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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., and E. S. GREW, M.A.

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A Novel Use of König Flames.

By OUR BERLIN CORRESPONDENT.

IF gas be allowed to enter through a tube into a capsule closed by a membrane, and to issue through another tube, its speed of escaping will be altered by any vibration imparted to the membrane, and if the flame be lighted at the end of the tube its height will accordingly be dependent on these vibrations. This is what is known by the phenomenon of the flames of König. To demonstrate the presence of vibrations in the flame, a rotary mirror or a stroboscopical device is generally used, the latter enabling the shape of the oscillating flames to be investigated more closely. If the form and frequency of these vibrations have to be fixed by an objective record, they are photographed on a tape of paper unwinding in front of them. Mr. K. Marbe* has been engaged, in the course of his researches in the range of the Psychology of Language, in recording the oscillations of such flames by a method which is simpler and less expensive than photography. A tape of paper is unwound for this purpose at right angles to the diameter of a sooty flame, and the flame leaves on the paper soot spots corresponding to the shape of the oscillations.

A tuning fork of 300 vibrations was installed on a wooden box, open on one side, and having on the other a circular hole to which the capsule was fitted, the membrane lying immediately above the opening (Fig. 1). A horizontal roller, carrying a paper tape, was arranged at some centimetres above the point of the flame; and the tape was unwound at a convenient speed. As long as the tuning fork was kept at rest, a simple strip of grey colour was obtained. As soon, however, as the tuning fork was set into vibration, this record, as seen from Fig. 3, changed character, showing tongues pointing in the direction of motion of the tape. These tongues seem to be the image of part of the luminous sheath of the flame.

The author succeeded in transmitting the vibrations of a telephone membrane to a König flame, and in registering them according to the process thus described, replacing the membrane by the telephone membrane, which was set vibrating by the alternating current from

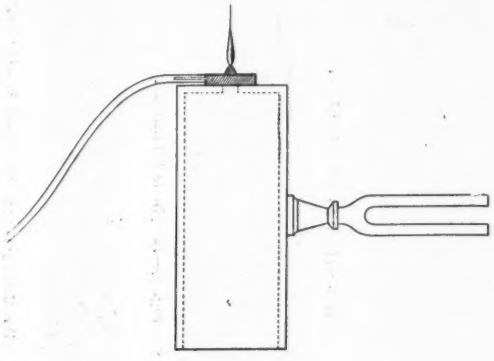

Fig. 1.

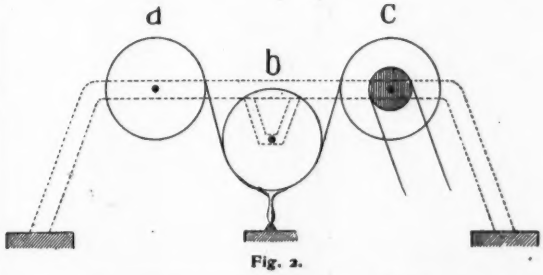

Fig. 2.

Apparatus for producing smoke records by a König flame. (1) Flame and resonating box. (2) Tape for smoke records.

the municipal mains. Figure 4 shows the results thus obtained. He, moreover, ascertained the frequency of this current by the aid of two flames connected to the telephone membrane and to the tuning fork respectively.

The idea then presented itself of transmitting the human voice to the membrane, and of trying to fix it graphically according to the same method, the membrane being connected in the ordinary manner to a

* *Physikalische Zeitschrift*, No. 15, 1906.

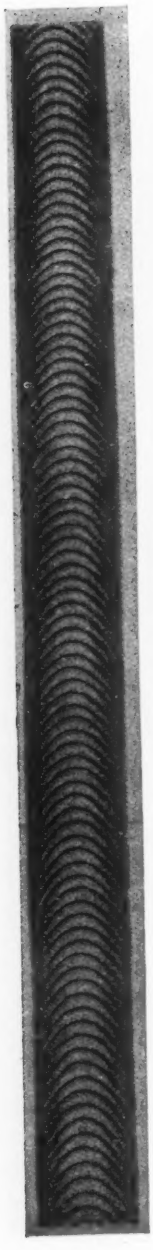

Fig. 3.—Tuning Fork Vibrations.

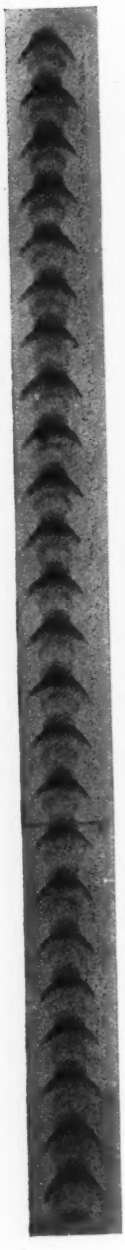

Fig. 4.—Telephone Vibrations.

Fig. 5.—Vibrations produced by Vowel Sound "ah."

Fig. 6.—Vibrations o Vowel Sound "a."

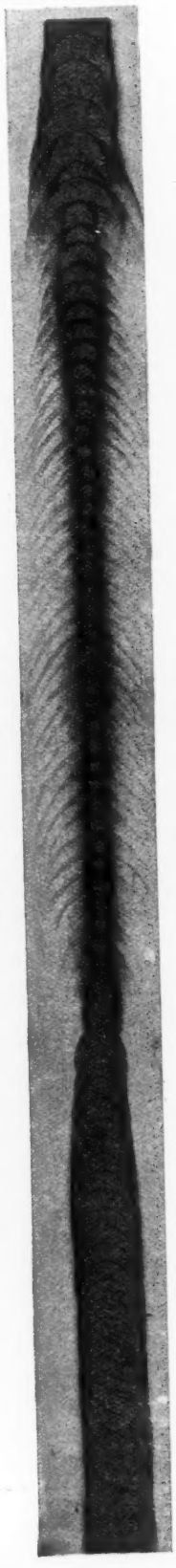

Fig. 7.—Vibrations of Sound "an."

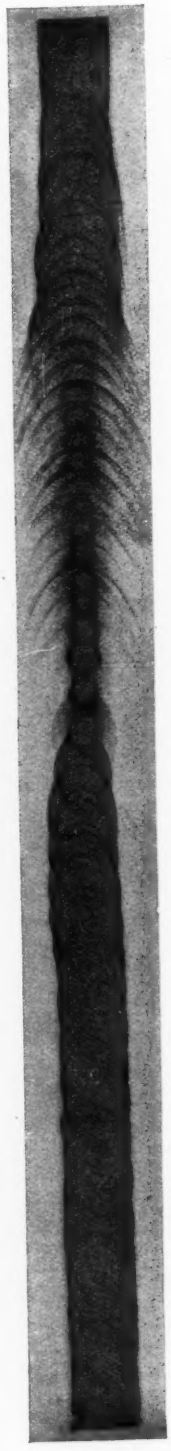

Fig. 8.—Vibrations of Sound "fang."

Smoke Records of a König Flame.

microphone. The characteristic images of the vowels a, e (German) are reproduced in Figures 5 and 6, in which the whole vibrations will be accurately ascertained. The same process, moreover, as seen from Figures 7 and 8, allows whole words to be analysed. Mr. Marbe's process seems to be destined to give rise to interesting discoveries in the range of acoustics as well as of phonetics. The author is at present engaged in constructing an apparatus enabling the pictures of such sounds as make up a continuous speech to be recorded graphically. This apparatus is to be combined with a counting device, marking on the tape tenths of a second, and is to be used in connection with statistical research work on the tune of human speech, researches which constituted the starting point of the present investigation. It may be said that their interest will be the higher, as no means of obtaining repeated and extensive records of human language has been so far forthcoming.

The Flora of the Presidency of Bombay.

THIS local flora, intended as a supplement to Hooker's "Flora of British India," should have been completed in January last by the issue of the sixth part; but Dr. Cooke, C.I.E., who has been engaged on the work at Kew for the past five years, has found as it progressed that the number of plants requiring description has constantly increased, and application has been made to the Secretary of State for India, who is subsidising the publication, for permission to exceed the limits originally laid down. Two additional parts have been sanctioned, and the complete work will not be issued until 1908. Part six is now in the press; the five that have already appeared have received many expressions of approbation from botanical experts, and from the non-scientists, revenue and district officers, and others, for whose use the book is designed.

The only existing regional flora is that by Dalzell and Gibson; this was published in 1861, and is now very incomplete, the knowledge of the vegetation of the Presidency having been added to so largely by the work of the Botanical Survey of India during the past fifteen years. The new flora will meet a want widely felt by all whose duties make it advisable that they should be acquainted with the characters and properties of the plants of the province.

It has long been the desire of Dr. Cooke to compile this manual, for which he had gathered much valuable information while acting as Honorary Director of the western branch of the Botanical Survey. He was for twenty-eight years Principal of the College of Science at Poona, and on his retirement in 1893, the Government of Bombay, acting on the recommendation of Sir George King, the Director of the Survey, wished then to entrust him with the work, but Lord Kimberley, the Secretary of State, vetoed the proposal, and it was not until 1901 that official sanction was given for its preparation. As the flora has been completed, the large private herbarium, formed by Dr. Cooke while in charge of the Survey in Bombay, has been made over by him to the Poona herbarium, to replace the loss by fire of the Government collection there in May, 1902.

World Weather.

By SIR JOHN ELIOT, K.C.I.E., F.R.S.

THE Meteorological Office has recently issued a memoir entitled "The Life History of Surface Air Currents: A Study of the Surface Trajectories of Moving Air."* It gives the results of the investigations of Dr. Shaw, Director of the Meteorological Office, and Mr. Lempfort, his scientific assistant. The research marks an important advance in the scientific work of the office, and suggests that in future improvement in the practical work of forecasting will be based on the results of scientific investigation rather than on empirical or experimental inferences. It is, however, of special importance as it employs novel methods for the investigation of air movement on the large scale—which are leading to results not merely unexpected, but opposed to the fundamental principles which have formed the chief stock-in-trade of meteorologists during the past fifty years.

The most important principle hitherto utilised by meteorologists is that connecting pressure of gravity forces and air movement. It is usually stated in the form that air invariably moves from positions of higher pressure to those of lower pressure (the pressure being reduced to sea-level equivalents). In the other form (a development of the pressure) air is assumed to move along planes of equal pressure, inclined to the horizontal, or from positions of higher to lower level, and hence under the action of gravity. In addition to these laws and modifying their application is the principle first largely utilised by Farrel, that air moving on the rotating earth is always being deflected to the right of its path by a force or amount depending on its velocity and latitude position on the earth's surface, but *not* on the direction of the movement. It is apparently assumed that air never moves from positions of lower to higher pressure, or from positions of lower to higher level. This is certainly, more especially in the latter case, opposed to ordinary dynamical principles and experience. For example, the bob of a pendulum moves for one half of its period of a single oscillation from higher to lower level under the force of gravity, and during the second half from lower to higher level with respect to the horizontal plane. Similarly, if the actual air motion be assumed to take place along an isobaric plane it follows that it may not only move down the plane from higher to lower level (acquiring momentum and kinetic energy), but also if it possesses momentum it may move in the opposite direction from lower to higher level (losing kinetic energy). Similar arguments might be applied to the pressure principle. The preceding remarks are simply intended to show that if ordinary dynamical (not hydrodynamical) principles are applied to meteorological investigation, their limited application in the form usually adopted by meteorologists is apparently neither valid nor justified by dynamical methods. Meteorological problems are chiefly problems of air movement, as changes of temperature, and humidity, rainfall, &c., are primarily the results of air movement. Hence the necessity for the study of the phenomena of air movement, from theory as well as from observation.

Air movement on the large scale may be that of the permanent or periodic circulations (as, for example, the trade winds and monsoon winds), and that of anticyclonic or cyclonic conditions, more or less temporary

* "The Life History of Surface Air Currents: A Study of the Surface Trajectories of Moving Air," by W. W. Shaw, Sc.D., F.R.S. (Director, Meteorological Office), and R. G. K. Lempfort, M.A. Published by the authority of the Meteorological Committee. (Wyman & Sons, H.M. Stationery Office, 1906; price, 7s. 6d.).

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in character, and in their most acute form, termed in ordinary language, "storms." The chief features of the first class of air movements have been determined both from observation and theory. The movement undoubtedly depends upon large temperature differences between the equatorial and polar regions, or between sea and land areas. With respect to the air movement in cyclones and anticyclones there is, on the other hand, much diversity of opinion. Meteorologists, for example, differ as to the conditions necessary for the initiation and development of cyclonic storms, the transformations of energy which occur during the storms, and also of the actual features of the air movement. Farrel, on the whole, the most distinguished American meteorologist, resolves the air movement of a cyclonic system into circular movement about a moving centre on a rotating surface. On this assumption he explains the incurvature of the winds and the contrast of the intensity of movement in different quadrants of the storm. The initiation of cyclonic storms is ascribed by him to temperature differences, and he classifies them into storms with a central warm area, and with a central cold area. The leading German meteorologists, we believe, now hold that cyclonic storms are mere incidents in the larger atmospheric circulations, just as a whirl in a stream of running water, is a mere eddy in the general stream movement, and due to some slight local obstruction or other cause.

With respect to the diversity of opinion on this point, Dr. Shaw, in his memoir, remarks: "I think I am justified in saying that meteorologists are even not quite clear as to whether the circulation of a revolving storm as shown on weather maps is the primary element of the problem, the *fons et origo malorum*, or is merely an exaggerated bye-product of more general atmospheric currents, possibly in the upper regions, just as the eddy or the whirlpool is the bye-product of the flowing stream and its boundaries." Dr. Shaw's criticism of the vague and careless employment of meteorological terms by meteorologists generally is both just and deserved. In connection with his investigation he especially instances the use of the terms barometric minimum and movement of a barometric minimum, pointing out that they are used to designate phenomena of different orders, and hence to suggest similarity when there is no similarity. It is, on the one hand, universally admitted that pressure is never absolutely uniform over any large area, and that it is in a state of constant flux or change by amounts differing from place to place due to a variety of actions, of which one is the movement of storm areas or barometric minima of a definite type. It is, for example, possible in a hot country like India for pressure on one day to be lowest in, say, Sind, on the next day in North-Eastern India, and on the following day in Burma or the Deccan. Weather charts drawn for short intervals of, say, one hour, might indicate the gradual transference of the seat of lowest pressure from Sind to Chola Nagpur and the Deccan. But to treat this apparent transfer by the same methods and subject to the same general laws as the movement of the centre of an intense cyclone is absurd, as it assumes similarity of conditions and actions where no such similarity exists. The changes of pressure accompanying the advance of cyclonic storms appear to be mainly due to internal actions, whereas in the other class of barometric minima referred to they are chiefly the result of external actions. Hence, to employ Dr. Shaw's words, "Treating the apparent displacement of all barometric minima generally in the same manner tends to obscure rather than to elucidate the difficult problems associated with the origin and march of storms."

How far this confusion taints the results of many meteorological investigations can only be surmised. It is, however, certain that more exact definitions and methods of investigation are essential for the progress of the science of meteorology. Assuming that there are cyclonic storms having a definite continuous existence and associated with certain peculiarities of air movement, the investigation of the motion of the air masses within the storm area or passing through it is evidently a problem of the greatest importance. Hitherto, chiefly due to the almost exclusive study of daily weather charts, little or nothing has been done to trace the continuous movement of the air masses affected by the cyclonic storm. The movement of the centre of the storm or of the isobars or the direction of the winds in relation to the position of the centre with respect to that of the position of observation, have hence been carefully studied from the charts, but these results tell us nothing of the previous or future history of the actual air mass passing over the place of observation, and hence throw little or no light on the conditions which determine the changes of temperature, humidity, and rainfall at the place of observation. Meteorologists are now agreed that what are called circular storms are not circular in the proper sense of the word. There is not merely a flow of air round, but also convergence towards a central area. There is also a large upflow over and near the central area, and also an outflow above and a descent probably in the outskirts of the storm area. The motion is hence successively complicated. It is also very variable, as squalls and gusts of the most violent character may alternate with strong but less destructive winds. Also in the cyclonic storms of the temperate regions of the northern hemisphere, the winds in the same quadrant of cyclonic storm, and hence from the same general direction, differ largely in their meteorological character (that is, temperature, &c.). These differences are, as Dr. Shaw has now shown, due to the previous history of the particular air mass in the given position of the storm in question. Hence the value and importance of Dr. Shaw's investigations.

The chief method of investigation employed is simple, but requires almost continuous registration of the air movement at a large number of stations in the area passed over by the storm. This is possible in the British Islands, as self-recording anemographs are in operation at many places. The path of a given mass of air is worked out from their observations by a step-by-step method. The following gives a statement of the method by means of a particular case. Suppose at a place the 8 a.m. observation shows that 20 miles of wind from W.S.W. has passed over it during the previous two hours. Half of this is assumed to indicate the movement of a mass of air during the previous hour (7 a.m. to 8 a.m.), and the remainder the movement of the same mass from 8 a.m. to 9 a.m. Suppose, then, an instrument observing at the new position shows that during the two hours preceding 10 a.m. 24 miles of wind from S.W. has passed over it. It is then assumed that the previous mass of air will have moved 12 miles from S.W. to N.E. between 9 a.m. and 10 a.m., and the same amount from 10 a.m. to 11 a.m. These values are plotted on a chart, and inferences from similar observations from noon onwards are made. The broken line thus obtained will give an approximation to the motion at the earth's surface of a definite air mass. The paths thus obtained are termed "trajectories" by Dr. Shaw. The method is undoubtedly only approximate, and subject to limitations. So far as we can judge, its employment is legitimate, and the conclusions thence established by Dr. Shaw and Mr. Lempfort are valid.

They have worked out a large number of trajectories for each of a series of typical storms which have passed over the British Islands in recent years, and formulated inferences of great interest and importance respecting the movement of air into or out of storm areas. The following gives a brief summary of what appears to us to be the most im-

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portant of these conclusions :—(1) In travelling storms, while in the front portion there is motion of the air from higher pressure to lower pressure, associated with falling temperature and with the gradual development of cloud and rainfall, there is also in the rear, sometimes from points quite near to the centre, motion of air from lower pressure to higher pressure and higher temperature with improving weather, and again there are instances of motion with practically no change of pressure, temperature, or weather. Over the Atlantic, air moves generally from higher pressure to lower pressure, but sometimes from lower pressure to higher pressure. There are also instances of air moving for long distances with little or no change of pressure. (2) An essential difference must be drawn between fast travelling storms (as estimated by the ratio of the velocity of the centre to the speed of the wind) and slow travelling storms. The former take all their air for the part which is represented by circular isobars from the region on the right hand or southern side of the path in the front of the storm and throw out an approximately equivalent amount on the same side in the rear. A slow travelling storm makes use of air from both sides of its path. That from the right hand or southern side flows directly towards the central portion, while that from the northern side curls round the rear of the storm. This difference in the characteristics of the two types cannot be accounted for by regarding all approximately circular storms as revolving vortices of air carried along by currents of different velocities. (3) In travelling storms the veering of wind is not generally a uniform sequence. Winds from some of the directions are relatively transient; on the other hand, winds from other directions are relatively persistent during the passage of the storm, even at considerable distances from the centre; the transition from the one persistent direction to the other is comparatively sudden. In fast travelling storms the directions of the more persistent winds are S. or S.W. and N.W., while in the case of slow travelling storms the more persistent winds are E. to N.E. and S.W. to S. (4) On the eastern side of the Atlantic, surface air currents from the south are generally short lived, and soon disappear in the central portions of cyclonic depressions. Only in fast travelling storms do southerly currents continue beyond the path of the centre and describe loops round the centre. (5) Air currents from other directions than the south are much longer lived. They persist until either (*a*) they reach the trade winds, or (*b*) turn round the rear of a depression and approach the centre from the southward, or (*c*) join a depression over the Western Atlantic. (6) The rainfall incidental to travelling storms can be, generally speaking, related to the ascent of air from the surface, as indicated by the convergence of the air, deduced from its motion, in a region not far distant from the locality of the rainfall, generally to the south or south-east of it. (7) The regions of high pressure that intervene between depressions and travel with them may be called anticyclones when we are dealing with a chart for a restricted area, but they are to be distinguished from the well-defined anticyclones which are persistent for days together. These latter are for the most part inert and comparatively isolated masses of air, taking little part in the circulation which goes on around them. (8) The motion of air with reference to the moving centre of a cyclonic depression is not, as a rule, properly described as circular motion round the position of minimum pressure, modified by incurvature, and transformed into spiral motion about a moving centre. The description would apply to the motion of air in the case of certain currents commencing on the northern side of a slow travelling storm, but the following cases of motion also occur :—(*a*) in approximately straight lines leading towards the minimum or a point on its path in front, or on the trough line of a V-shaped depression, (*b*) round the minimum in curves, to which the minimum stands rather in the relation of the focus of a conic than that of the centre of a circle.

Space does not permit us to discuss to what extent these conclusions, if valid, will modify the body of conclusions known as "the laws of storms," and hence the methods and practice of forecasting in the English Meteorological Office. In conclusion we congratulate the Meteorological Office on the results of the investigation. It is an example of the importance of research based on scientific methods which is now essential to further large progress in the improvement of the practical work of weather forecasting.

The Carriers of Plague.

"Pulex Cheopis."

So long has plague in India been associated with rats that there is a proverb to the effect that "when the rats begin to fall from the roof, it is time for people to leave the houses." The Indian rat falls from the ceiling cloths and mud roofs of the Indian go-downs and bungalows and huts because it is a house rat and not a sewer rat like the English variety; and, consequently, the incidence of an epizootic of plague among rats in India is usually marked by the deaths of numbers of them in and about the walls and ceilings. And generally this appearance of plague among the rats is followed by the appearance of plague among human beings. But though there seemed thus an immense probability that plague among rats was transmitted to human beings, there has been great difficulty in proving it, and the difficulty lay in fixing on the means of transmission. This difficulty has been disposed of by the investigations of the latest scientific commission, which was appointed by the Indian Government, and which is still pursuing its work. So important are the results of its first year's inevstigations, and so decisive are they, that they have been published as an interim report in the "Journal of Hygiene." They establish definitely the fact that the chief carrier of plague from rat to rat, and from rat to man, is the rat flea "Pulex cheopis."

The commission, instituted by the Indian Government, at the instance of Dr. Martin, F.R.S., Director of the Lister Institute, comprised Major Lamb and Captain Liston, of the Indian Medical Service, Dr. Petrie and Mr. Sydney Rowland, of the Lister Institute, and several Indian investigators of plague, Mr. Kasava Pai among them, lent by various Indian States. The commission had to set about its work from the beginning, and unprejudiced by the conflicting experiences and theories of preceding investigators. For, although evidence in support of the connection between plague among rats and plague among human beings has accumulated since the discovery of the plague bacillus by Yersin and Kitasato, there have been many negative results in the attempt to demonstrate the belief positively. Most of the observers who have studied the question on the spot—Yersin, Ogata, Simond, Thompson, Koch, and Gaffky—have arrived at the opinion that from an epidemiological point of view plague is to be regarded as a rat disease in which human beings may participate. The relationship of the epizootic among rats and the epidemic among human beings has been particularly studied with great care for the outbreaks in

Sydney by Ashburton Thompson (1902, 1903, 1904); in Port Elizabeth by Blackmore (1902); in Hong Kong by Hunter (1904); as well as in Cape Colony by Mitchell (1906); in Queensland by Baxter-Tyrie (1905); and for Calcutta by Pearse (1905). In India the connection was scientifically indicated, if not established, by Snow and Weir (1897), Hawkin (1898), and the German commission (1899). But as late as the report of the last Indian Plague Commission (1903) no definite conclusion was reached as to the share which rats take in disseminating plague. (The introductory preface in commenting on the contradictory nature of the evidence, remarked that it was not clear whether rats contracted the disease after its appearance among the human community, or whether they introduced it, or even whether it was shared by human being and rat alike.)

There have been similar difficulties in determining how the infection was conveyed from rats to human beings, or from rats to rats. One way of conveying the infection would arise from the cannibal practice which rats betray of eating one another's dead carcasses. But it has been shown that a very large amount of plague-infected carcass absorbed in this way is necessary in order to contract plague, and in any case man would not contract the disease in this way. That insects were the carriers of infection occurred to several investigators. Yersin (1894), Hawkin (1897), Nuttall (1897), Ogata (1897), and Simond (1898) examined flies, ants, fleas, and bugs, and found plague bacilli in their bodies, but though Simond succeeded in conveying plague from rat to rat by means of fleas, there were a number of unsuccessful experiments, and this want of success was recorded by Nuttall and Tidswell, and by the German Plague Commission, and by others who believed in this method of transmission. A few theorists objected to the hypothesis on other grounds; the chief of which was that the rat-flea was indigenous to the rat, and would not bite human beings or other animals. These objections have been finally disposed of by the identification of the characteristic rat-flea as "Pulex cheopis," and by the proof that it will, and does, bite other animals.

We shall make the process of proof most clear by recording briefly the results of the experiments made by the Plague Commission. (1) It was first shown by confining rats in separate wire boxes, so that they could not come into physical contact, that plague could none the less spread from a plague-infected rat to a healthy rat. (2) It was shown that plague might be conveyed to guinea pigs in the same way. (3) On the other hand, close contact of plague-infected animals with healthy animals did not give rise to an epidemic (epizootic) among the healthy animals if fleas were excluded. Nor did plague-infected animals, if the same principle of exclusion was observed, convey the disease to the young they were suckling. (4) When, however, fleas were admitted to the colony of animals the epidemic, once started, spreads from animal to animal, the rate of progress being in direct proportion to the number of fleas present. (Special precautions eliminated the possibility of air-borne infection in these experiments.)

That plague can be conveyed from animal to animal by means of the rat-flea was thus shown, together with a presumption that this was the principal means of conveyance. This presumption is strengthened by other experiments. It is shown both directly and indirectly that in a plague-infected house the infection may be due to the presence therein of rat-fleas, which are capable of transmitting the disease to animals. The direct proof was obtained by allowing guinea pigs to run free in plague houses which had been previously disinfected, but in which there were still fleas—as was shown by their subsequent discovery on the guinea pigs. The guinea pigs contracted plague, and the fleas caught on them were found capable of conveying plague to healthy animals. When guinea pigs, placed in a plague house, were isolated in gauze covered cages in such a way that fleas could not reach them, the guinea pigs did not contract plague. If in a cage where they could be reached by fleas, the guinea pigs died in several cases. The microscopic examination of the fleas which the guinea pigs attracted in plague houses revealed the presence of the plague bacillus in their intestines.

One indirect testimony to the superior effectiveness of the flea as a vehicle of plague was afforded by the experiments made with regard to the infectivity of plague localities on the floors and walls of plague houses—irrespective of the presence of fleas. The plague bacillus disappeared from floors and walls much more quickly than had been thought probable. It remains to record the possibility that other insects besides fleas may convey the infection, and a suggestion (noted in the preface to the report) that plague may be a disease of fleas.

Alcohol as a Stimulus to Life.

IN the second number of *Science Progress* (John Murray) the place of honour is given to an extremely lucid and suggestive article by Mr. W. B. Hardy, F.R.S., of Caius College, Cambridge, in which he treats of "The Physical Basis of Life" from the point of view of the structure of atoms. In the course of the article he refers to the various experiments of Messrs. Maupas, Calkin, and Woodworth in estimating and prolonging the number of generations of the tiny organism *Paramœcium caudatum*. Normally the vital impulse of this organism dies out after the 170th generation, but Woodworth succeeded in prolonging its existence to the 860th generation by supplying it with appropriate stimulant. The stimulant tried on the Paramœcia with most success was—alcohol! "It was added to the water in which the animals lived, so that they were always immersed in one part of spirit in 5,000 to 10,000 of water"—an experience resembling in a diluted form that of the Duke of Clarence's adventure in a butt of Malmsey. In the effect produced there was the touch of Nature which makes the whole world kin. The periods of depression were wiped out. The curve of vitality no longer showed the ominous recurrent falls. At the same time the rate of growth and division, that is to say, the physiological activity, was increased by as much as 30 per cent. Something of the same effect was produced by strychnine, but there was a remarkable difference in the fundamental action of the two drugs, for whereas the beneficial effect of alcohol endured after the drug ceased to be administered, that of strychnine did not. Alcohol exacted no "physiological usury," in spite of the prodigiously increased rate of living. It was beneficial in its after effects. Other articles of importance in *Science Progress* are "Some World's Weather Problems," by Dr. W. J. S. Lockyer; the "Origin of Gymnosperms," by Mr. Newell Arber, and "The Igneous Rocks," by Dr. J. W. Evans.

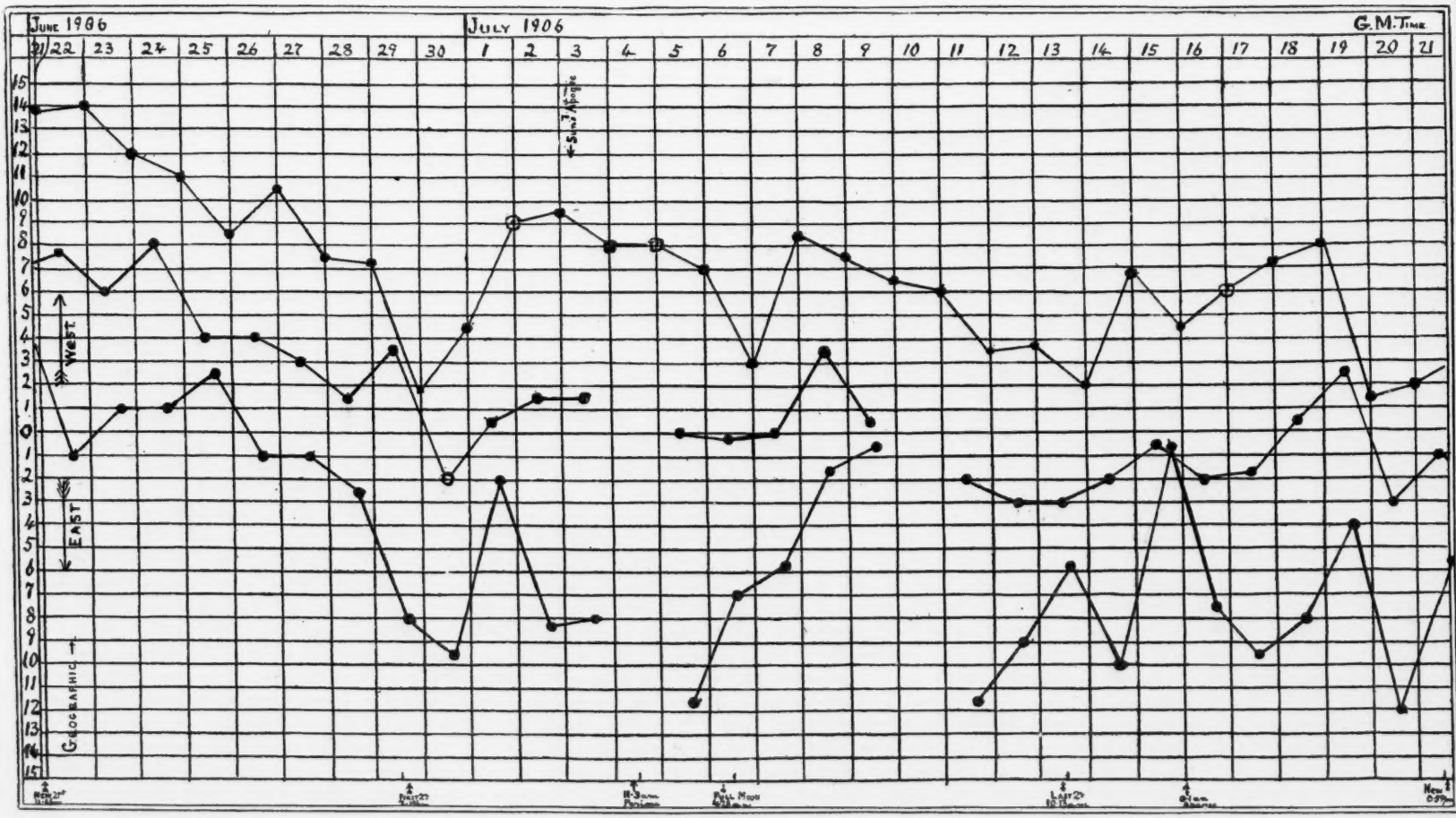
MESSRS. F. DARTON AND CO., the well-known manufacturing opticians and scientific instrument makers, were awarded a Grand Prix and Diplôme d'Honneur at the Milan Exhibition for their manufactures.

Lunisolar Variations of Gravity.

BY W. H. SHARP.

SPECIMEN Chart for one Lunar Month, extracted from Charts of Diurnal Electric Tidal Variations of Gravity, as exhibited by the movements of a ball of lead at the end of a brass tube, freely supported as a "Sharp's Pendulum" (*vide* "KNOWLEDGE," October, 1906), in a room about 10 ft. × 9 ft. × 9 ft. capacity, situate in 0° 3′ E. Long., 51° 32′ 40″ N. Lat.

The original readings were taken direct from a tangent scale of millimetres, which is here represented as four times enlarged. Only the means of the oscillations observed at midnights, noons, and minima respectively are here shown, by dots as in three series—upper, middle, and lower. The lines connecting the dots have no connection with this record, except as links showing sequence. The four light dots are interpolated from contiguous means in the day curves. The black dots represent direct mean readings.



Earthquakes.*

By CAMILLE FLAMMARION.

THE alarming eruption of Vesuvius was hardly over than the world was aghast at the earthquake of San Francisco. The Italian volcanic eruption lasted from the 5th to the 12th April; and the North American earthquake began, at 5.13 on April 18, with a violent trembling of the earth in vertical, horizontal, and oblique oscillations, and, as we know, it caused the overthrow in the course of two or three minutes of the greater part of the "Queen of the Pacific," and it was followed by an immense fire. Four hundred deaths were the consequence, and the financial loss was computed at four hundred millions of dollars. This disastrous shock was followed by several others, notably that of the 20th April, and the 19th May.

California has always been subject to earthquakes. In a list of the seismic disturbances in California, Professor Holden reports as many as 514 in the whole State, 254 being in the territory of San Francisco alone, and this only from 1850 to 1886. During the nineteenth century there have been ten serious shocks, and in 1868 a part of the town was destroyed.

The towns and villages on the zone of maximum of intensity were cruelly affected for the length of 180 miles (290 kilometres), from Santa Rosa to Salinas.

The last eruption of Vesuvius and the earthquake of San Francisco, following the earthquake of Calabria, which continued from the 8th to the 15th September last, the one in India on the 4th April, so replete with terrible consequences, and the many slight shocks observed everywhere, lead us to study these phenomena of nature by the help of the most recent investigations of science. The planet which we inhabit does not possess the apparent stability which it presents to the mind uninstructed by history and science. The intensity of seismic shocks and the elasticity of the terrestrial globe was seen in the great disaster of Assam. This earthquake, which was not less disastrous than that at Lisbon in 1755, took place on the 12th June, 1897, and the tremors of the earth not only spread from this spot to the antipodes, but they were registered again on the seismographical apparatus of India, after having twice made the tour of the globe, like the atmospherical and marine waves caused by the gigantic explosion of Krakatoa in 1883, which I showed in my special work on the subject.

The earthquake at San Francisco seems to have been of the same intensity and energy as those of Lisbon and Assam. It was registered by all the seismometers of the globe, and it was not till they had twice made the tour of the world that the tremors decreased in force. I have before me the diagrams of the oscillations in England (Birmingham), Belgium (the Royal Observatory of Uccle), Austria (Laibach, etc.), and they show the course of this wave. It passed Birmingham at 1.25, by Greenwich time. As the time of 5.13 at San Francisco corresponds to that of 1.13 at Birmingham, we see that it only took twelve minutes to go from San Francisco to Birmingham. It arrived at the same time at Brussels (Uccle), and a little later in Austria, where the apparatus registered an oscillation lasting from 2.30 to 3.30. The time of Central Europe is in advance of Greenwich time. Mr. Davison's study of the oscillations of Birmingham showed that a second registration followed the first in 3 hours 13 minutes, *after having made the tour of the whole world.*

If to the 40,000 kilometres, which represent the tour of the world, we add the 9,000 kilometres which separate Birmingham from San Francisco, we see that the first impulsion was powerful enough to cause a vibration which resounded at least to the distance of 50,000 kilometres.

The vibrations produced by the earthquakes are transmitted at a different rate of speed through the entire mass of our planet to that with which they pass along the external crust.

On the 2nd February, the seismometer of the Observatory of Florence registered a disturbance 9,000 kilometres off; and on that day a submarine volcanic eruption and a tidal wave destroyed the town of Buenoventura, a port of Columbia, on the Pacific Coast. I also stated, on the 7th March, that the central meteorological bureau of Vienna, in Austria, registered on the night of the 18th-19th February, an earthquake 12,000 kilometres off, which proved to be the violent shocks at Martinique, Saint Domingo, Saint Lucie, and a part of the Antilles, and the recrudescent activity of the mountains of Peleus.

The shocks at San Francisco were remarkable for their length and their rotary character. The violent phase lasted forty seconds, but it was three minutes and a-half before their registration was concluded by the apparatus of the Naval Observatory of Mare Island. Before their destruction, it was noticed that many houses had left the straight line. A whole street rose up like a wave several metres long. In Calabria and elsewhere, deep, open crevices were made by these dislocations.

Earthquakes vary as much in the distance of their effect as in the intensity. Some, like those of Lisbon in 1755, or Assam in 1892, are felt two or three million square kilometres away, and others do not vibrate further than a hundred or ten square kilometres. In 1879, the inhabitants of Linthal, in Glaris, were thrown out of their beds, whilst fifteen kilometres from there nobody felt it. It has been generally supposed that earthquakes are the consequence of volcanic eruptions. This idea is evidently erroneous, and nowhere is it more proved to be wrong than in Japan.

Everybody knows that Japan is *par excellence* the land for earthquakes, as it has as many as three or four a day. But the most unstable regions are not by any means those contiguous to Fusiyama, the great Japanese volcanic mountain, which, moreover, has been quiet for the last three hundred years. No eruptive manifestation accompanied the great seismic disturbances of 1891 and 1897, but many earthquakes have taken place in regions not at all volcanic. At San Francisco, for example, there is no volcano; and there have been earthquakes in many other spots where the volcano is absent or where, if it exists, it has shown no activity. Seismic disturbances are not caused by volcanic eruptions, either near or distant. But the seismic disturbances and volcanic eruptions are both due to the pliant state of some region of the earth's crust.

Seismic disturbances are always in the neighbourhood of mountains. The most prolific regions are those of a steep decline. The regions of a slight decline are those which, at 200 kilometres from the sea, have only a slope of from five or ten degrees; and places where, at the same distance from the seashore, there is a steep descent exceeding three degrees. All the regions which are incontestably seismic have a fall of three

* Translated by Rachel Challice (Member of the Astronomical Society of France).

to five degrees, particularly in Japan. Seismic centres abound especially where there are such contrasts as a steep submarine strata, terminating in a very abrupt terrestrial slope. There are constant disturbances along the crevasses. There is a shrinkage of the crust along the dislocations, and they provide, as it were, a safety valve for internal disturbances. In other words, the volcano and the earthquake are brothers and not father and son, as it has been thought for a long time in default of sufficient observation.

The secular cooling has induced folds and hollows of solidified external crust on the pulpy shell, which goes on contracting, so that these noises are not only rumblings, but they are accompanied by movements; for the enormous pressure from the interior induces upheavals and volcanos. Heat, hot water, and steam, are all at work; ruptures of equilibrium are accompanied by puffs of elastic gas, showing the existence under our feet of a considerable tension, which is always ready for action.

Chains of mountains and maritime slopes result from the gradual cooling of the globe, the cracking of the crust, which, being forced to a base, descend more or less. These cracks cannot occur without some disturbances; and, as I said before, they occur constantly every day and every hour. We only notice the most violent ones, which bring disaster to us. But, as a matter of fact, earthquakes are regular and normal episodes in the life of our planet.

The new science of seismology has been created by statistics, agglomeration and classification of the documents. Alexis Peirey, a learned compatriot and colleague of the Academy of Dijon, made a catalogue of the thousands and thousands of shocks mentioned everywhere from 1844 to 1872. I tried to continue this catalogue in my review, *Astronomy*, from 1883 to 1888, with the help of my laborious colleague, C. Detaille. But these statistics took up so much room that we had to give them up. It has been continued for several years, with scrupulous and indefatigable care, by M. de Montessus, of Ballore, in the excellent Belgian review, *Ciel et Terre*. This mass of documents records more than 170,000 earthquakes, which give room for the study of seismological geography. According to the general synthesis of M. de Montessus, of Ballore, which embraces the whole world, it is seen that the terrestrial crust trembles nearly equally, and almost solely along the two narrow zones which cross at an angle of 67 degrees, the Mediterranean or Alpine Caucasian and the circum-Pacific circles. These two zones coincide with the two most important lines of the terrestrial surface. Earthquakes are common on the most mobile strips of the terrestrial surface, where great accumulations made have been dislocated and raised in the tertiary period, before the formation of the principal actual chains.

Birkbeck College.—The Rt. Hon. R. B. Haldane, M.P., distributed the prizes at the Birkbeck College, on Friday, October 26, and lectures have been delivered during the past month by Professor Flinders Petrie, Mr. S. L. Bensusan, and Professor H. Von Herkomer, R.A. Among the other lecturers of the present term are Mr. Hilaire Belloc, M.P., Dr. James Cantlie, Mr. E. Thompson Seton; and next term lectures by Mr. E. T. Reed, of *Punch*, Miss Gertrude Bacon, and Dr. J. D. McClure, F.R.A.S., are promised. The summary of examination results shows that in the past year fourteen Birkbeck College students passed the London B.Sc. (six with honours), and five the B.A. final; twenty-eight the Intermediate Science, and seven the Intermediate Arts.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Photography of the Infra-Red.—M. G. Millochau describes in the *Comptes Rendus* (1906, cxlii. 1407, and cxliii., 108), the method he is employing for photographing the infra-red and mapping this part of the solar spectrum. He follows on the lines adopted by M. Stefánik, who, by the use of coloured screens to absorb the more easily visible parts of the spectrum, finds that he can get the extreme violet (H and K) to appear very brilliant, and can easily see to about $\lambda 3830$ (L), which is as far as some glass instruments transmit, and can similarly extend the visibility of the spectrum in the infra-red. M. Millochau uses a deeply-coloured alcoholic solution of chrysoidine, malachite green, and aniline violet to cut off the light other than the extreme and infra-red. The plates used are first exposed to diffused light to fog them, advantage being taken of the fact that the light at the red end of the spectrum reverses or negatives the ordinary exposure effect. But as the reversing action has been found to be little more that superficial, it is advantageous to stain the film and so prevent the preliminary exposure effect from penetrating so deeply as it otherwise would. The preparation of the plates in actual practice is as follows:—Lumière's Σ plates are soaked in water for fifteen minutes, then soaked in a well-filtered, saturated alcoholic solution of either chrysoidine, or erythrosine, or (less advantageously) eosine, rapidly rinsed, and dried. The preliminary exposure follows, artificial light being used, but further details of it are not given. By this means M. Millochau has mapped the solar spectrum from $\lambda 8377$ to $\lambda 9325$.

Reversal by Red Light.—It is interesting to note that the reversing action of the extreme red and infra-red rays, as mentioned in the previous paragraph, is almost superficial, as this is evidence in favour of the supposition that the air has something to do with the reversal, and that perhaps it is due to oxidation, a theory that has been suggested by several observers, especially Abney. But all exposure effects begin at the surface that the light impinges upon, and one would like some proof, in this particular case, that the infra-red light really has had time to work through or well into the gelatine film, so that the superficial character of the reversal is not due merely to a want of penetrating power of the light. In this connection may be noted the recent observation of Messrs. Precht and Stenger, that reversal by over-exposure is retarded by treating the plate with a 1 per cent. solution of a developing agent before exposure, a plate so treated requiring more than forty times the exposure it previously needed to produce reversal; as well as the much older experiments of Abney, in the similar use of reducing agents, and the exclusion of air. But in forming a theory as to the action of light in producing reversal effects, it is not sufficient, as one is so often tempted to do, to consider experiments of one kind only, how-

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ever conclusive they may appear to be. A theory of reversal naturally includes, or is a part of, the theory of the character of the thing reversed, that is the developable image, and this is a large subject. Reversal, as well as the developable condition, appears to be producible by any form of energy, but it has been found that the reversibility of the developable image depends upon the method by which the developable condition has been produced, as well as the method by which the action is supplemented in order to get reversal. These observations are referred to more at length in this Journal for August, 1904, and seem difficult, if not impossible, to reconcile with the theory that so many are satisfied with at the present day, namely, that the changes are simply chemical, the developable image consisting of a reduction product of the silver bromide, and reversal being a process of oxidation.

Smoking Sensitive Paper for Recording Instruments.—Referring to the method of using sensitive paper in self-recording instruments that I described two months ago, Mr. Thomas Bolas, in the *Amateur Photographer*, says that: "The operation of smoking the paper is an extremely delicate one, but when done successfully the film of carbon is uniform, grainless even under a high power microscope, without tendency to scale off, and so thin as to give a bare line or tracing without roughness. In smoking paper it must be held by two opposite edges, so as to stretch the sheet on a metal surface, this surface being a portion of a cylinder. A broad-wicked paraffin lamp may be used for smoking, or, better still, a number of small pieces of camphor laid in a row and lighted."

Photographing Medals, Coins, etc.—The well-known similarity between the representation of a sunk and a raised design is taken advantage of by M. E. Demole (*Comptes Rendus*, 1906, cxlii., 1409), in the photography of such things as medals. An impression of the article is obtained in dull lead foil, and the concave side of this is photographed under oblique illumination directly on to bromide paper, without the use of an intervening negative, the double lateral reversal giving an unreversed print. The details of the operation are not further described.

Picture Post-Cards.—The postal facilities accorded to "picture post-cards" are equally available for any form of pictorial or graphical communication, so that the methods of making them may sometimes be of practical scientific interest. Seeing that a good card is made by sticking together a number of sheets of paper, it seems to me a great waste of time and trouble to treat the card as a whole, that is, to first stick the sheets together and then sensitise, expose, develop, and finish the photograph on the card, when the photographic work would be more quickly and advantageously done on the outer sheet of paper before it was stuck to the others to form the card. For the photographic sheet, ordinary bromide or other printing paper might be used, and when the "picture" is completed it might be made into a card by sticking the necessary paper sheets at the back of it. The paper bearing the photograph and the other sheets that go to make up the card should all be rather larger than required, and the whole finally trimmed to size. I do not know whether trade printers of picture post-cards adopt this method, but it appears to offer many advantages.

A Long-Lost Beetle.

Non equidem invideo, miror magis.

ONE day in September last four persons might have been seen on a Surrey common, turning up spadefuls of the heath-clad sand, and scrutinising them with eager eyes and fingers. "Treasure seekers," said the passers by, and they were right; but we were prospecting after no vulgar treasure. Three of us, it should be said, were amateurs, the fourth was an insectarian of note.

Two hundred years ago, the great Sir Hans Sloane discovered on Hampstead Heath, and added to the British fauna, a strange beetle, captured parasitic in a nest of the "Bloody Ant" (*Formica sanguinea*). It was duly chronicled, described, exhibited at a meeting of the lately founded Royal Society, and received the name of *Lomechusa strumosa*. It may be seen to-day in the museum, side by side with a second specimen unaccountably taken soon afterwards in the Mail Coach between Gloucester and Cheltenham. This was in 1710; until now no third example had been noted; it came to be looked upon as dubious or extinct, and has long been omitted from the published lists of British species.

Towards the end of July in this year, the long-lost insect was re-discovered by an enthusiastic coleopterist, and it was under his guidance that we were rummaging the clods. He failed on this occasion to unearth *Lomechusa*; but he showed us several mounted specimens from the former find, and we were rewarded by meeting with another extraordinarily rare beetle, resembling a tiny crocodile, and known as *Dinarda dentata*. The "Bloody Ant" nests in old fir-stumps, or burrows into banks, concealing its nest with grass. It is a slave holder, carrying off in their pupa state, and training to obedient servitude, the young of *Formica fusca*. *Lomechusa* is fed by its hosts; they obtain from it, in turn, a sweet secretion, which deteriorates the nursing instincts of the workers, causing pseudogynes, or false queens. It is constant to *F. sanguinea*, being never found in nests of the adjacent large "Wood Ant," *Formica rufa*.

To a humanistic student, the genus specialist is not less interesting than are to himself the prizes of his own research. Our friend, we found, was not a naturalist, not an entomologist, not even a coleopterist; all our general questions as to Hampton Court spiders, male wasps, death watches, he smilingly put by. Of beetles inhabiting ants' nests, and of their entertainers, he knows what is to be known, and lives in hopes of knowing more; all other knowledge he shuts out. Some day, I suppose, this micromania will exhaust itself; there will be no tiny worlds to conquer, no more quiddities to reveal; we shall admire, instead of classifying, shall once more see Nature whole, shall revert for the poetry, the power, the picturesqueness of zoology, to the pages of a Buffon, a Linnæus, a Gilbert White.

W. M. T.

The "Unilens."

THE short account in the last number of "KNOWLEDGE" of the "Unilens" has elicited a good deal of comment. This correspondence is in accord with my preliminary experiences. When first this simple idea occurred to me I went to consult several opticians. But all said at once that the use of one lens as a telescope was impossible. I took a specimen into a certain shop and explained that the arrangement acted most satisfactorily, at all events as regarded my own eyesight. But the proprietor was obdurate, and merely said "That will never do." "But look for yourself," I urged, holding the instrument before him. Yet he would not even condescend to look through it, saying, "You *must* have a second lens near the eye before it can be any good," and I came away leaving him absolutely unconvinced. Now some letters have been sent to "KNOWLEDGE," of which two are by recognised authorities on optics. One correspondent, dating from the Athenæum Club, says: "A person with normal vision . . . . cannot, with the 'Unilens' focus anything that is more than two or three feet beyond the glass. In order to obtain a sharp image of an object beyond that distance, he must render himself artificially hypermetropic, by using as an eyeglass a concave lens . . . . " and adds: "If the inventor finds the instrument as practically useful as your note suggests that he does without an eyeglass, the inference is that he has at least two dioptres of hypermetropia, of which possibly he is unaware." An oculist writes: "You say that it is always in focus; now, I submit that the rays of light, being convergent, are *never* in focus for an emmetropic person. The very definition of an emmetrope indicates this—one in whose eyes, without accommodation, parallel rays are focussed on the retina."

Well, what is my answer? I find that nearly everyone to whom I have shown the instrument (I can only recall five exceptions) can see clearly through it, and find it useful for magnifying distant objects. Are we, then, to understand that all these people have "at least two dioptres of hypermetropia?" If so, despite its long name, I think it is a very convenient malady to suffer from.

Mr. Wentworth Sturgeon, on the other hand, writes to say that his father many years ago introduced a closely similar instrument. It is but natural that so simple a device should have often been tried before, and though I had never heard of its being previously adopted, I do not claim any originality in the appliance beyond the details of its present form.

B. BADEN-POWELL.

Ancient Mazer in Epworth Church.

AN early example of the Mazer is religiously preserved among the old communion plate in the parish church of Epworth. It was originally a wassail-bowl and was presented to the church by Duke Thomas, one of the great family of Mowbrays, who resided in the castle hard by, when he came to Epworth to bid farewell to his wife before his banishment by order of Richard II.

The vessel is now used as an alms dish; it is a curious bit of antiquity, and the most interesting object in the church. It is constructed of maple wood, mounted in silver-parcel gilt. The rim of silver is ten inches in diameter. The religious device engraved on a large silver button in its centre has the Holy Family surrounded by a moulding ornamented with rays of glory and the figures of St. John the Baptist and St. Andrew with St. Andrew's cross.

A special interest will always attach to the old communion plate of this church as having been so many years in the possession of the Wesley family and as having been used in the Holy Service by John and Charles Wesley.

The chalice is dated 1706; it is very beautiful and of historic interest. The flagon is an ancient pewter.

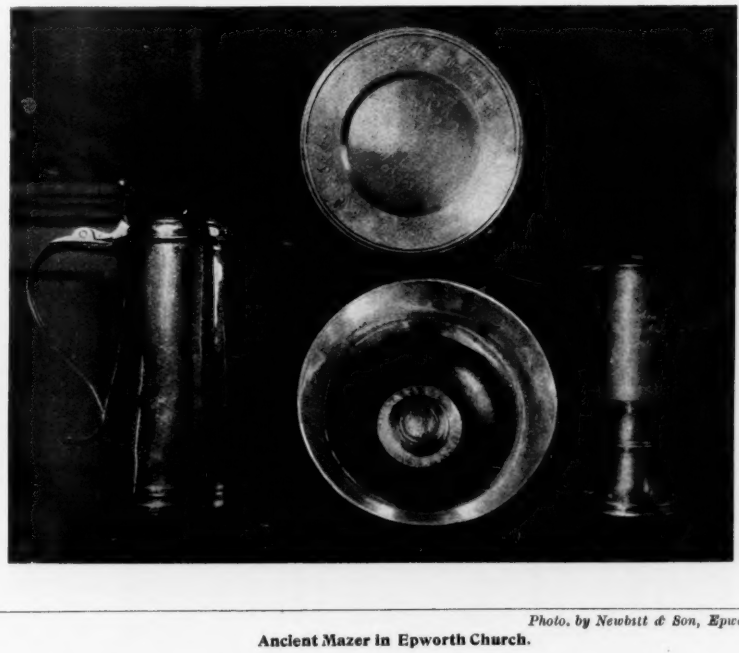

Photo. by Newbitt & Son, Epworth.

Ancient Mazer in Epworth Church.

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The So-Called Copper Teeth of Cattle.

IN the Deer Lodge Valley, Montana, adjacent to the great Butte copper district, the so-called copper teeth of cattle attract enough attention to make it worthy of record along with the "So-called Gold Coated Teeth of Sheep," as reported in "KNOWLEDGE AND SCIENTIFIC NEWS," Vol. III., No. 15, page 359.

The lustrous copper or gold coloured coating (popularly called "copper teeth,") is general in this region in cattle, and occasionally seen in horses and sheep. The description of the "So-Called Gold Coated Teeth," referred to, accurately described the deposit found on the teeth in the cases here reported.

An analysis of this incrustation made by Mr. H. N. Thompson, Chief Chemist of the Anaconda Copper Mining Company, shows the deposit to be chiefly calcium phosphate, with some organic material, but no copper.

The report of the analysis shows:—

Insoluble residue,	CaO . .	35·5%
	P_2O_5 . .	34·5%
Ignition loss . .	CO_2, H_2O, Organic Matter . .	25·0%

An interesting fact in this connection is that boiling seems to bring out the lustre, and many jaws which normally have a blackish or brownish colour, on boiling assume the copper or gold lustre.

It is worthy of note in this connection that these deposits occur in a region whose waters are strongly alkaline to cochineal solution, and further, because of the arid climate, there are large quantities of soluble soil constituents present, with a consequent high ash percentage in the plants grown upon it.

CORRESPONDENCE.

Electrical Nitrates and Fertilisers.

TO THE EDITORS OF "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—While accepting "J. H. M. H.'s" correction as to the general destination of nitrate of soda as a manure, I should like to point out that the impression of its uses in promoting the growth of wheat is one which is widespread. For example, in the opening sentence of Mr. J. B. C. Kershaw's article, in the current number of *Science Progress*, on "The Artificial Production of Nitrate of Lime," he begins:—"Since Sir William Crookes startled the scientific world, eight years ago at Bristol, by pointing out that the corn supply of the world was dependent upon the ample provision of nitrates to the soil, and that we were rapidly depleting our reserves of the only naturally occurring nitrate—namely, Chili saltpetre—scientists in all countries have been attempting to solve the problem of the extraction of nitrogen from the air in the form of nitrite or nitrate." I have referred to Sir William Crookes' own observations, and I find that he said: "It is now recognised that all crops require what is called a dominant manure. Some need nitrogen, some potash, others phosphates. Wheat preeminently demands nitrogen, fixed in the form of ammonia or nitric acid," and again, after a long passage referring to the cultivation of wheat alone, "The only available compound containing sufficient fixed nitrogen to be used on a world-wide scale as a nitrogenous manure is nitrate of soda, or Chili saltpetre. This substance occurs native over a narrow band of the plain of Tamarugal in the northern province of Chili. . . The nitrate fields of Chili have become of vast commercial importance, and promise to be of inestimably greater value in the future."

Sir William Crookes, who, of course, was unaware in 1898 of the experiments (quoted by "J. H. M. H.") taking place in 1905 at Rothamsted, went on to say: "The action of nitrate of soda in improving the yield of wheat has been studied practically by Sir John Lawes and Sir Henry Gilbert on their experimental field at Rothamsted. This field was sown with wheat for thirteen consecutive years without manure, and yielded an average of 11.9 bushels to the acre. For the next thirteen years it was sown with wheat, and dressed with 5 cwt. of nitrate of soda per acre, other mineral constituents being present. The average yield for these years was 36.4 bushels per acre, an increase of 24.5 bushels. In other words, 22.86 lbs. of nitrate of soda produce an increase of one bushel of wheat."

I trust that "J. H. M. H." will take steps to make Sir William Crookes aware of the extraordinary error into which he fell in believing that "wheat was in any sense dependent for its profitable cultivation upon nitrate of soda."

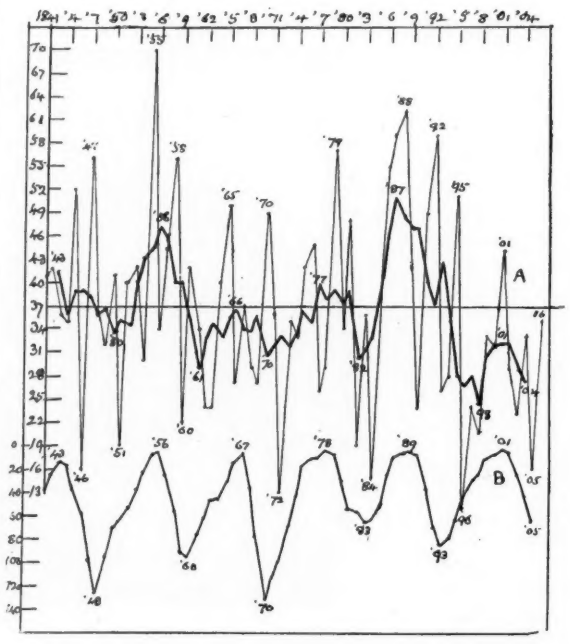
I am, sir,
Yours faithfully,
G.

Sunspots and Cold.

TO THE EDITORS OF "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In an article on "Coming Cold" in "KNOWLEDGE" for 1897, p. 241, is a diagram which seemed to me suggestive of a connection between sunspots and winter cold in the early part of the year (as measured by the number of frost days at Greenwich).

It might interest some of your readers to see how things have turned out in those nine years from 1897.



The thin curve A shows, then, the variations in number of frost days in the earlier half of each year, and in the thick curve each year point represents an average of five values. Below (B) is the inverted sunspot curve.

In that article I wrote: "It seems to the present writer that we are now about the beginning of another of those long waves of the smoothed curve of frost days, which may be expected to culminate near the next sunspot minimum.

At what date may we look for that minimum? Taking the eleven years' period as our guide, about 1900; but the interval, it must be remembered, varies. . . The new wave seems at least likely to be lower than the last, and more of the order of the two previous."

The new wave has turned out quite a small one, with crest in 1901, the year of sunspot minimum, the cold then showing (as in 1866) a relative maximum. Judging by the present position, we should at least expect no extreme cold (high number of frost days) in the earlier half of 1907. (I may remark that the total of frost days in September to May appears to present similar relations, though perhaps less definite.)

I am, yours, &c.,
ALEX. B. MACDOWALL.

TO THE EDITORS OF "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I notice that you occasionally are good enough to answer queries from correspondents in your valuable monthly, which I have taken in for the last eighteen months, and I should be much obliged if you would explain the cause of the following phenomena.

Being very much interested in chemistry, and recently having had occasion to burn a small piece of phosphorus under a bell-jar for the purpose of seeing how much light was absorbed by the fumes, I held up the jar (with the plate at the bottom) to the light (incandescent gas). The mantle was visible through the fumes, and looked a milky blue colour, as one might expect. This was done when the fumes were densest.

When the fumes had subsided considerably I again held the jar to the light. I was surprised to see the fumes faintly (but distinctly) coloured in layers. The colour at the top was orange, then a thin layer of violet, then green, and lastly blue. Each layer blended imperceptibly with the next, like a spectrum, only apparently not quite in the same order. The best position for seeing the colours was when the jar was not quite between the eye and the light, but rather lower. When tipped to one side the colours kept the original horizontal level. When agitated the colours formed wavy lines, but soon regained the original level. As the fumes subsided more the orange colour gradually displaced the other colours until all the jar was diffused with an even orange colour. The jar used was $6\frac{1}{2}$ ins. by $5\frac{1}{2}$ ins., and the piece of phosphorus about the size of half a pea. The phosphorus was ignited by a hot wire, so that no other fumes were mixed with them. The colouring was not seen except between the eye and the light.

Apologising for troubling you,
I remain, Yours &c.,
P. H.

The Library, Buckhurst Hill.

[The colours are diffraction fringes formed in the same way as the colours often seen round the moon—the corona—when seen through a thin cloud. The blue fringe will be found to completely surround the flame, the tint gradually changing to orange outwards. The outer fringes are incomplete, due to the small size of vessel, and hence appear as bands.—A.W.P.]

"Pendulums Used in Gravitation Research."

TO THE EDITORS OF "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Kindly permit me to correct three errors which have occurred in reproduction of my diagrams on page 561 in your last issue, as they are liable to cause misapprehension.

1st. The dotted lines suggesting the changes of oscillation plane which distinguish the Foucault pendulum are omitted from Fig. 2.

2nd. The curious "smudge" upon the pendulum rod in Fig. 4 is not an intended portion of the diagram itself.

3rd. The ring in Fig. 7 to which the wire was hooked, and which was the distinctive feature of that pendulum, is omitted.

Yours truly,
W. H. SHARP.

Manor Park,
October, 1906.

A Peculiar Optical Effect.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I have frequently noticed a peculiar effect where a number of straight lines run in close proximity, which I am unable to account for. I refer to the fact that (to most eyes at all events) horizontal lines are more easily distinguishable than vertical lines. This is shown in the diagram I send herewith. One would be inclined, on first looking at it, to think that the horizontal lines were further apart than the vertical ones, yet on turning the whole paper round to a right angle, those lines which were vertical become horizontal, and are then much clearer than the others.

The effect may be even more noticeable if looked at from some distance. But now another curious result comes in. To my eyes, when the paper is held at a distance (say six feet), the horizontal lines are distinctly the clearer, but if I use strongish glasses, even though the lines be slightly out of focus, the vertical ones are undoubtedly the more distinguishable.

This effect has its practical value, for draughtsmen will find it better, when using a fine scale, to place it so that the lines run horizontally, turning the paper round if necessary.

Perhaps some of your readers can explain the cause of this.

Yours faithfully,
B.

Answers to Correspondents.

A. Handel Smith.—The most complete tables of physical and chemical data are to be found in Landolt-Börnstein, Physikalisch-Chemische Tabellen (Williams and Norgate, London). The Chemist's Pocket Book (E. and F. N. Spon) also contains numerous tables. It is impossible to advise further without knowing the particular tables required.

Halley's Comet.—Various dates have been put forward for the return of this interesting comet, but the data are not rigid, and consequently the predicted positions and times of perihelion are given with some variance by different authorities. The first predictions were for 1911, then 1912, but the most recent is that for 1910, May 24. May 16 of the same year has also been mentioned.

Artificial Respiration.

THE newest method is that of Dr. Eisenmenger, of Hungary, who proposes to restore respiration by acting only on the abdomen, without causing any movement of the thorax. To this end he has devised an apparatus that enables him to increase or diminish at will the atmospheric pressure on the abdomen by a species of suction. A sort of cuirass, fitted with straps and a pad, is tightly fitted over the abdomen and lower thorax in such a way as to leave an empty space beneath the cuirass and the fleshy parts of the stomach and abdomen. The air in this hollow can be compressed or exhausted by means of a pneumatic tube and bellows, and thus the movable envelope of the abdomen can be alternately raised and depressed. Thus the rhythmic movement is transmitted across the soft internal organs to the diaphragm, which it moves in a corresponding way, thus causing inspiration and expiration. The heart is also affected, and thus gently massaged, and its movement stimulated.

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NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Studies of the Sun's Heat Emission.

MM. CH. FERY and G. Millochau describe their preparations for making a new series of determinations of the sun's calorific emission, using for the purpose their pyrometric telescope. They consider the apparatus specially suitable for heat sources of definite area, as the recording part may be adjusted with great delicacy. For these experiments, a special form of the instrument has been constructed, consisting of a silvered-glass mirror, 103 mm. diameter, and 800 mm. focal length. At the focus of this mirror is placed a thermo-electric couple of similar construction to those employed in the Fery commercial pyrometric telescopes. Behind the thermopile is a total reflection prism serving to direct the rays coming from the mirror into an ocular, mounted on a movable dark hood. The observer looks into this in a similar manner to that followed when using a Newtonian reflector, and sees in the eyepiece the thermopile, forming a reticule superposed on the magnified image of the celestial object under examination. Delicate focussing mechanism is provided to adjust the reticule exactly at the focus of the mirror. The telescope tube proper is closed by a diaphragm composed of two metallic rings, one fixed, the other movable. Each ring has a sector opening of 90°, so that any required opening may be used, the actual amount being recorded on a divided circle.

The current generated in the pile is measured with a galvanometer having a movable coil.

By permission of M. Janssen, it has been arranged to make successive determinations at four stations of different altitudes, Meudon (150 m.); Chamounix (1030 m.); Grand Mulets (3050 m.); Janssen Observatory, Mont Blanc (4810 m.).

The observations will be of two classes:—(1) Measures taken at various hours of the day, by placing the centre of the sun on the centre of the thermo-electric reticule. (2) Observations of the various amounts of radiation of the several parts of the solar disc. This will be done by allowing the solar image to drift over the reticule, noting the galvanometer readings and the times; then by plotting the readings the values for any section can be deduced.

It is stated that the curves obtained thus far agree with those shown by Wilson's 1894 results.—(*Comptes Rendus*, 143, p. 505, October, 1906.)

Recent Views on Terrestrial Magnetism.

M. Carl Störmer has for some time past been developing a mathematical theory of the aurora and magnetic perturbations in relation to Birkeland's hypothesis, supposing that these effects are due to electric corpuscles emanating from the sun, and moving under the influence of terrestrial magnetism. He gives certain of the formulæ derived by Poincaré's method, showing that it may be possible for a swarm of electric particles moving along certain trajectories to show evidence of perturbations more or less periodic. The velocities used in the discussion are those given by Rutherford for cathode rays, and the α and β rays of radium. The values determined are found to be of the same order as Eschenhagen's oscillations, and the dimensions of the trajectories vary greatly with the nature of the corpuscles.—(*Comptes Rendus*, 143, p. 460, October 1, 1906.)

Colours and Spectra of Solar Prominences.

M. Ricco, observing at Alcala de Chisvert, in Spain, during the last total solar eclipse, on August 30, 1905, obtained direct photographic confirmation of the continuous spectrum of the solar prominences, which has been described by M. Deslandres. As seen visually, the prominences were of different colours in different parts; the bodies of the prominences were purplish red; the circumference of the chromosphere was purplish; and the summits of the jets were very clear purple, almost white, and very brilliant. Several chromospheric plumes were seen sufficiently colourless to correspond with the white prominences recorded by Tacchini.

Of especial interest are the results found on the photographs taken with a prismatic camera, showing monochromatic images of the uneclipsed parts of the solar surroundings. These show many important variations in the radiations of hydrogen, helium, and calcium. The photographic images of certain prominences in K light show a height of 79″-83″ while the same objects seen visually in the C line were only 64″ high. It is suggested that this greater height of violet radiation may be the cause of the phenomenon of white prominences. Several of the prominences show definite continuous spectrum from the red to ultra-violet (λ 3600). There appears to be a special class of prominence formed solely of calcium vapour.

Total Solar Eclipse of August 30, 1905.

Spectra of Chromosphere and Corona.—Professor F. W. Dyson has made a complete examination of the spectra photographed by him with the slit spectroscope, and included in the discussion the results obtained with the same instrument during the previous eclipses of 1900 and 1901. Observing in 1905, at Sfax, he was able to secure an excellent photograph of the corona spectrum, showing several new lines. The list of chromospheric lines given from the combined photographs is very complete, extending from λ 3347.98 to λ 5875.87, and shows the intensity, probable origin, laboratory intensity in spark or arc, and details by other workers for each line. Detailed discussion is given of the mode of occurrence of each element. It is noticeable that the helium lines and the element giving λ 4685.86, are stronger in the higher than in the lower chromosphere. The enhanced iron lines appear to be weakened in the higher chromosphere in comparison with the magnesium arc lines and the enhanced titanium lines. From the experience gained in these three eclipses, the author concludes that a slit spectroscope is most advantageously used when it is adjusted as nearly as possible tangential to the sun's limb at the point of second contact, this applying both to the chromospheric and the corona spectrum. The paper is illustrated by an excellent reproduction of the corona spectrum, showing the two new lines at 5117 and 5563.—(*Phil. Trans. Royal Society*, Vol. 206, Series A, pp. 403-452.)

Photographs of Corona.—The Rev. A. L. Cortie took charge of the Stonyhurst College Expedition to Vinaroz, Spain. His chief instrument was the coelostat and long-focus lens belonging to the Royal Irish Academy, which had been used in 1900. Six photographs of the corona were obtained, the size of the moon's diameter being about $2\frac{1}{6}$ inches, the exposures varying from 4 to 50 seconds. After the very striking prominences in the north-east, the most conspicuous object is a group of plumes with a decided dark ray about position angle + 125°.2. The dark ray can be traced to about 12′ from the moon's limb, and both its darkness and its peculiar character differentiate it from the other rifts between streamers. As it rises it curves somewhat towards the north, and becomes broader. In negative 4, another dark ray seems to be superposed on the bright plume at position angle + 136°, but this cannot be traced on any other photograph. The paper is illustrated by four reproductions of the corona.—(*Trans. Roy. Irish Academy*, xxxiii., Sect. A, Part I.)

Widened Lines in Sun-spot Spectra.

Professor C. Michie Smith has recently issued another circular, giving the lists of solar lines intensified or otherwise affected in sun-spot spectra. The observations extend from F to D, and cover the period 1905, July 5, to 1906, January 4. Thirty-three spots were examined, and an appendix shows the special points noted for several lines.—(*Kodaikanal Observatory Bulletin*, No. 6.)

Oxford University Observatory.

In his report on the work of the University Observatory for 1905-6, Professor Turner states that the printing of the Oxford portion of the Astrographic Catalogue was commenced at Christmas, and the first of the eight volumes is nearly completed.

The expedition to Assouan, Egypt, to observe the total solar eclipse of August 30, 1906, was successfully carried out with the assistance of Captain Lyons. Several satisfactory photographs of the corona were taken with the astrographic object glass, one being through a green-colour screen. Pictures in polarised light were obtained with two small telescopes. It is hoped to measure these plates at the earliest opportunity.

The event of the year was the meeting of the International Union for Co-operation in Solar Research in Oxford, at the New College. Delegates from the various scientific institutions of the world attended and discussed the problems most in need of attention at the present time.

BOTANICAL.

By G. MASSEE.

Macroplancton of Paraguayan Ponds.

DR. CHODAT, in *Bull. Herb. Boissier*, distinguishes between Microplancton and Macroplancton, including in the former all microscopic organisms, and in the latter the larger free floating plants belonging to the Archegoniates and Spermatophytes, including species of *Salvinia*, *Utricularia*, *Lemna*, &c. Among remarkable species occurring in Paraguay are *Utricularia inflata*, common in swamps, having the inflorescence supported by verticillate leaves arranged in horizontal bands, cut into shreds at the extremities, and inflated at the centre. *Phyllanthus fluitans*, a curious plant belonging to the Euphorbiaceæ, which simulates a *Salvinia*, occurs floating amongst species of *Salvinia*, *Azolla*, and *Lemna*. The leaves are almost orbicular, and float on the surface of the water. A broad, flat margin encircles two more or less dome-shaped elevations, one situated on each side of the mid-rib on the upper surface of the leaf. Two depressions on the under surface of the leaf, corresponding in position to the domes on its upper surface, are filled with imprisoned air, and serve as buoys to float the plant. The minute flowers are situated in the axils of the leaves. The stem produces numerous much-branched, positively geotropic root fibres devoid of root-hairs, and terminated by a short adherent cap. Another interesting swamp plant, *Alternanthera Hassleriana*, has a floating stem which attains a length of 20 cm., the internodes are cigar-shaped or spindle-shaped, hollow, and when young are covered with a dense coat of interwoven hairs. A quantity of air imprisoned in this felt assists in enabling the plant to float. Tufts of erect leaves, also the flowers, spring from the nodes. The roots spread outwards in two tufts from opposite sides of the nodes, thus preserving the equilibrium of the floating structure.

Anthoceros and its Nostoc Colonies.

The association of colonies of *Nostoc* and other allied forms of minute blue-green algæ with certain of the more highly organised plants has long been known, and has led to much speculation as to the significance of such unions, but until quite recently no specific experiments have been instituted with the object of arriving at a more definite conclusion. Peirce has just described, in the *Botanical Gazette*, a series of experiments and cultures bearing on this subject, where *Anthoceros*, one of the liverworts, which has been supposed to habitually contain colonies of *Nostoc* in its thallus or vegetative portion. Minute filaments of the alga enter the substance of the liverwort through certain slits present in the surface of the thallus, and afterwards increase rapidly and form colonies in the substance of the thallus. Prantl has stated that *Anthoceros* derives benefit from the presence of *Nostoc*, assuming that the latter might fix the free nitrogen of the air, and contribute its products to the liverwort. He also points out that the liverwort forms free hairs, which penetrate into the *Nostoc* colonies present in its tissues, ostensibly for the purpose of absorbing the food-supply furnished by the *Nostoc*. Finally the thallus cavities containing the alga show a characteristic development. Peirce combats these statements as follows:—*Anthoceros* grown as pure cultures and quite devoid of *Nostoc* colonies proved to be more vigorous in every respect than others containing colonies of the alga, and, furthermore, many of the liverworts not grown as pure cultures, were also free from *Nostoc*. As to the statement that the blue-green algæ fix free nitrogen, it is pointed out that the weight of evidence is against this assumption. It is also shown that the structural peculiarities presented by *Anthoceros* when *Nostoc* is present are simply a matter of mechanics. The denser tissues surrounding a colony is due to pressure exercised by the constant increase in size of the colony on the surrounding tissues, and the ingrowth of hair-like structures into the *Nostoc* colony is due to the fact that the colony is not equally dense and resistent at all points of its surface, and hair-like outgrowths of the surrounding *Anthoceros* cells grow into the alien colony at the points of least resistance.

Zanczewske, on the other hand, considers the algal colonies as parasitic on the liverwort. This idea, however, is not supported by Peirce's experiments, although he is not prepared to state definitely that no parasitism exists, but concludes by stating that *Nostoc* certainly does not benefit *Anthoceros*, which, in fact, does better without it.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

The Sacred Water of Mecca.

A RECENT issue of the *Lancet* gave the results of an analysis of water taken not long ago from the Zem-Zem well at Mecca, and it is interesting to compare the figures with those obtained by the present writer in the examination of the water brought back, in 1854, by Sir Richard Burton from his celebrated pilgrimage (see "KNOWLEDGE," 1894, vol. XVII., p. 56). The recent sample of the water was contained in a soldered tin bottle, in which was also a rusty-looking sediment, which proved to be iron hydroxide. The water, which Burton obtained at the risk of his life, was also sealed up in tin bottles of a peculiar shape, but in that case the only insoluble matter was in the form of beautiful silken crystals containing tin derived from the interior of the flask, and there was no iron present.

The *Lancet's* sample contained 200.2 grains of solid matter per gallon, 49.7 grains of chlorine, and 0.28 grain of nitrogen in the form of nitrates. The residue when heated gave off a sickening odour and turned black. The writer in the *Lancet* points out that the water contains about 90 times as much free ammonia as is present in ordinary water, and remarks that "to call it polluted would be mere euphemism." This fully bears out the present writer's conclusion, and is not surprising when it is remembered that for generations this water has been poured over myriads of pilgrims, who drank what they could as it ran down them and back through a grating into the well. Hence, the water has become little better than sewage effluent. That brought home by Burton contained 219 grains of solid matter, 69.3 grains of chlorine, 19.9 grains of nitrates, 5.3 grains of

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ammonia, and 0.22 grain of albuminoid ammonia. It was strongly saline, the chief salts present being ordinary salt and magnesium sulphate. Sir Richard Burton commented upon its extreme bitterness, and gave a humorous account of his attempts to make his fellow-pilgrims drink more of

Tin flask of Zem-Zem Water brought from Mecca in 1854 by Sir Richard Burton.—Four-fifths of actual size.

their dose of Epsom salts, while he "mocked at their scanty and irreverent potations." The water has evidently altered but little in its general characteristics of foulness during the last half century, and must still be regarded as permanently dangerous in itself, apart from the share it has been known to have from time to time in spreading diseases such as cholera.

Volcanic Ash from Vesuvius.

Specimens of the substances thrown up by Vesuvius during the last great eruption in April of this year have been examined by M. Cosyns, of Brussels. The ash was remarkable for the small amount of moisture it contained—only 0.28 per cent. On treatment with water it yielded 1.68 per cent. of soluble substances, consisting principally of calcium sulphate and sodium chloride. Roughly speaking, the ash was composed, in the main, of 50 per cent. of augite (a silicate in which iron and calcium predominate), 40 per cent. of biotite (a silicate containing aluminium and magnesium), and 10 per cent. of leucite (sodium potassium and aluminium silicate), magnetite, &c. There was a distinct difference in the characteristics of the ash which fell on April 4 and 5, and of that which fell on the 14th, the former containing much more moisture and a larger proportion of vitreous fragments. On extraction with ether the ash yielded a small amount of a combustible organic matter, which distilled at a high temperature, had a tarry odour, and became brown on exposure to the air. It was found to be a hydrocarbon, and was evidently identical with the substance which Silvestri discovered in the ash from a previous eruption, and termed "vaseline." Similar hydrocarbons have been found in the ash from other volcanoes, and M. Cosyns considers that volcanic activity is more or less closely connected with chemical reactions that lead to the formation of hydrogen and hydrocarbons, often in considerable quantity. Notable instances in support of this view occur in the volcanic regions of the Apennines, where the combustible gases carry bitumen and petroleum to the surface of the soil; in the petroleum wells in the volcanic districts of Baku; and in certain springs of petroleum in Canada, which issue from a volcanic rock containing nodules of extremely radio-active bituminous carbon.

A Chemical Test for Mould Fungi.

The action of certain mould-fungi upon cinnamic acid has been utilised by M. Oliviero as a means of detecting their presence. Cinnamic acid, which is closely related to benzoic acid, occurs naturally in balsam of Tolu and in storax, and can be prepared from these resinous compounds in the form of fine feathery crystals. It can also be prepared synthetically from oil of bitter almonds. When distilled with an excess of lime it yields cinnamene, C_8H_8, a liquid hydrocarbon with a very characteristic fragrant odour. The reduction of cinnamic acid to cinnamene is also effected by a ferment (enzyme) secreted by certain mould-fungi, notably *Aspergillus niger*, *Penicillium glaucum*, and probably others. Thus when a well-developed culture of *A. niger* is thoroughly shaken and filtered through porous porcelain, and the sterile filtrate brought into contact with a weak solution of the sodium salt of cinnamic acid, the unmistakable odour of cinnamene at once becomes apparent. So sensitive is the reaction that cinnamic acid may be used as a test for the moulds which sometimes form in medicinal preparations that have been stored for some time. It also throws light upon the occasional rapid deterioration of pharmaceutical products, such as balsam of Tolu, which contain cinnamic acid.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

The Sand-hills of the River Bush

THE illustration shows an excavation formed by marine action in the sand-hills, which are now found at the mouth of the river Bush, on the northern coast of Antrim, the town of Bushmills being about a mile up the river. Probably at one time the embouchure of the river extended the whole of the way as far as the town, with a width extending from near the Giant's Causeway across to the headland at Port Ballintrae. The present meanderings of

Sand-hills and Baylet at Mouth of River Bush.

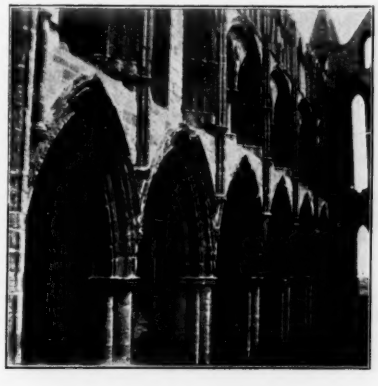
the river here are not, as is so often the case, the result of silting-up, but rather through the advance of sand-dunes blown inland from the ever-plentiful supply of sand forming along the coast. These low hills are devoid of consolidation, but are held together in some places by thick growths of grass. In the photograph a baylet has been formed, and this has been strewn with rounded blocks of basalt, from the disintegration of which the material of the hills has been derived.

Movements of Sand-hills.

Moving sand-hills have been the cause of much destruction. A well-known instance is that which occurred on the north coast of Germany, at the Kurische Nehrung. In 1809, the dunes stood between the sea and a church. By the movement of the sand the church was covered up in 1839. The moving dune passed on, and in 1869 the church was again completely visible, the dune then being on its landward side. Another similar instance is recorded, in which, between 1804 and 1827, a migrating dune in Prussia destroyed a tall pine forest, covering hundreds of acres.

Aeolian Denudation.

Nineveh was buried in æolian sand two centuries after its destruction, and the fretting of the sand grains left the marks of its denuding action on the building stones. Our second illustration serves as a remarkable instance of the action of wind-denudation. The pillars and various portions of the stone-work of Whitby Abbey, besides exhibiting the ordinary effects of aerial denudation, are scored in a noticeable way, as though an endless rope had been continually drawn to and fro over them. The sandy waste seems to have been



Aeolian Denudation at Whitby Abbey.

used over and over again as a kind of emery powder, and blown with terrific force against the sandstone pillars, and it has cut its way into the softer portions. This scoring can be seen in the illustration. The subject of æolian denudation has received a good deal of attention in recent years, and is becoming a well-recognised factor in modern geology. It is not a little remarkable that the same principle is being utilised commercially, and the sand-blast is being used as a denuding agent in the cleaning of the faces of buildings in which sandstone has been used.

The Plateau Bridge into Europe.

In Dr. Felix Oswald's treatise on the "Geology of Armenia," we have a monument of original research and patient industry. Dr. Oswald has personally studied the whole of the formations here exhibited, and besides giving an account, running into 225 pages, of geological work already done in this part of Asia, he gives the record of his own original work to the extent of 257 pages, illustrated by sections and maps, fully elucidating the text. He gives us a striking picture of the Armenian plateau, forming a portion of that long plateaux-chain extending from the Aegean across to China, a portion of the colossal wrinkle which extends also westward through Europe, and speaks of the great mediterranean sea of Central Asia, now represented only by evaporating salt-lakes. Along this belt is the zone of thick sediments of Cretaceous and Eocene age, which were plastic enough to be thrown into mountain folds. A striking map of Asia shows this central uprisen series of plateaux, squeezed, as it were, between the great active mountain-making pressure from the north and the passive resistance of the ancient table-lands of Egypt, Arabia, Hindoostan, etc.

A Record in Geological Publication.

Dr. Oswald's book deserves special notice here. It is his thesis accepted by the University of London for the degree of Doctor of Science, but is remarkable from another point of view. It is printed from type set up by the author himself, and printed page by page from a hand-press. The labour involved must have been very great. The maps have also been reproduced by the author, and the whole goes to form a book printed so clearly and distinctly as to make it a pleasure to read it. I hope again to take an opportunity of referring to it. For the present, I should like to say that its contents fully justify its publication, that the edition is limited to a hundred copies, and that the author invites subscribers at a guinea each. Application should be made to him at "Iona," Beeston, Notts.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Bird Protection Society.

THE Royal Society for the Protection of Birds, since its formation, has done more good and useful work than is generally realised. It is, therefore, with regret that we find ourselves compelled, for the moment, to enter a protest against some recent official utterances of the Society.

In a leaflet just issued (No. 58), we find the following stupid and ill-judged paragraph: "When it is regarded as a shameful and despicable thing to kill and possess the stuffed remains, or the egg, of a vanishing species, the private collector will probably cease to exist."

We are to suppose from this silly statement that the aim of the private collector is simply to complete the extermination of rare birds; and this, too, in spite of the fact that some of the most influential members of the Council of the Society are private collectors! The Society either knows too much, or too little, of the aims of the members who dictate its policy. Had the framers of this extraordinary paragraph levelled their guns at the collector of the eggs of British birds they would have hit many in this country very hard. The egg collector, is speaking generally, for there are many happy exceptions, a pest. And the man who gives long prices for rare birds—British killed—is only a little less mischievous. But between these "collectors," and the real student of birds, to whom a collection is an absolute necessity, there is a wide gulf, which the Society does not seem to recognise.

Glossy Ibis in Ireland.

It seems probable that a small flock of glossy ibises made their way to Ireland during September, since a young male is described in the *Zoologist* for October as having been shot on Twin Island, Belfast Lough, on September 9, while a second is reported in the *Field* (September 29) as having "recently" been shot on the Shannon, at Eyrecourt.

Hoopoe in Cheshire.

The *Zoologist* for October contains a record of the fact that a male hoopoe was "taken" near Chester, on August 29, this making the third record for the district.

Hobby in Cheshire.

We regret to note that a fine adult male hobby was also "taken" at Tarvin, near Chester, early in August, and has been presented to the Chester Museum. One of the most beautiful and most harmless of our falcons, it seems a pity that hooligans with guns cannot be induced to spare this bird.

Solitary Snipe in Norfolk.

Mr. Arthur W. Blythe writes to the *Field* (September 29) to say that a solitary snipe was shot by him at Melton Constable, on September 22, flushing the bird in a dry grass field.

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Late Stay of Swifts in Somerset.

In the *Field* (October 6), Mr. F. A. Knight records the fact that he saw, on September 30, at 8 a.m., a large number of swallows and martins, and among them were two swifts. The birds were flying east, along the north side of the Mendip Hills, at Winscombe.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

The Efficiency of Brakes.

THE recent accidents in connection with the running away of an electric tram at Highgate and the train near Grantham have both called renewed attention to the non-effectiveness of brakes when applied so as to lock the wheels. The problems raised are very difficult, and it does not seem very clear as to what the correct solution is. At one time I thought that the explanation was easy, in terms of energy considerations. The argument ran somewhat as follows: If the wheels are locked there is dissipation of energy only at the rails; but if the wheels are only partially locked there is dissipation also at the brake blocks; therefore the energy of the train will be more quickly removed in the latter case. This argument is, however, wholly fallacious, and may serve as an illustration of the danger attending arguments based on the doctrine of energy. It is easy to see that it must be fallacious by applying the method of forces. The motion of the train as a whole can only be altered by means of *external* forces. Now, the forces between the brake blocks and the wheels are *internal* forces, and, therefore, cannot *directly* affect the motion of the train. The only external forces on the train are between the wheels and the rails, and the brakes act by changing the rolling motion of the wheels to sliding motion. Unless, therefore, it can be shown that the energy dissipated at blocks and rails is greater when the wheels are partially locked than when they are wholly so, the energy argument proves nothing.

The important question to be answered is as to whether sliding friction, even when the rails are slippery with rain (or otherwise) or a smooth flat is formed on the wheels, is likely to be less than the mixed rolling and sliding friction which comes into play when the locking is imperfect. If we take the supposed superiority of partial locking as being an experimental fact, the answer to this question must be that the sliding friction *is* less. It must be admitted that this answer is not in agreement with preconceived expectations. It is certain that pure rolling is much less than sliding friction; and it is not clear how a mixture of the two can give rise to a resistance which is greater than either of them. The greater smoothness brought about by the formation of a flat on the wheel commonly gets the credit for this unexpected result; and it is possible that this is a sufficient reason. Again, the grip-and-let-go action which accompanies the mixed friction may not be without some influence, since static friction is always somewhat greater than kinetic. This paragraph is written rather with the idea of getting clear notions on the subject than of dogmatising upon it.

The Rate of Decay of Phosphorescence.

This subject has been recently attacked by the Rev. B. J. Whiteside, S.J., who has experimented on Balmain's paint. The method of experimenting consisted in placing a surface coated with the paint alongside a piece of glass of such a tint that when illuminated from behind it appeared of the same tint as the paint when excited by light. The source of illumination of the glass was a small hole in front of a lamp, and its strength could be adjusted by moving the lamp and aperture from the glass. This movement was effected in such a way as to maintain the brightness of the glass always of the same strength as that of the surface of the paint, as the phosphorescence died away. By means of a chronographic apparatus, the mechanism by which the movement of the lamp was made (and which was controlled by hand), automatically recorded the times at which successive measured distances were reached. Hence, by applying the inverse-square law, the intensity at any instant could be calculated. As a result it was found that the intensity could be represented very well by the formula $I(a+bt)$ const., where I = intensity, a and b are constants. The great interest in this result is that a similar formula has been found by Professor Trouton to apply to the release of strain of solids when stressed beyond their elastic limits, and the plausible inference is that phosphorescence is intimately connected with the effects following an actual deformation produced by the action of light.

Models of Atoms.

Professor Mayer's experiment with floating magnets has been utilised considerably by Professor J. J. Thomson, in illustrating the possible stable positions of electrons in an atom. A simple modification of this experiment was described by me in *Nature*, Oct. 4. Small floating magnets (*i.e.*, bits of magnetised needle, ½-inch long, each pierced through a small piece of cork, so that it will float vertically on water) are placed on water with their north poles (say) all pointing upwards. These, of course, will repel one another and in the usual arrangement this repulsion is balanced by placing below the dish a bar magnet with its north pole upwards; the magnets then take up equilibrium positions, which are of a regular kind. But instead of using this additional magnet, a force tending towards the centre of the dish can be obtained by filling the vessel almost to overflowing with water. A single magnet placed on the water will then float to the centre; two such magnets will float into stable positions, depending upon their strength of magnetisation. Three come to rest at the corners of an equilateral triangle. The chief interest in this modification is that the grouping is sometimes very different from that obtained in the usual form of the experiment. For example, in the latter, when six magnets are used, they will form an equilibrium figure, with one acting as a central nucleus, and the rest distributed round it at the corners of a regular pentagon. In the modified arrangement, a large number may be arranged in a single ring without any central nucleus. The maximum number depends upon the size of the dish and the particular magnets employed. Thus in a particular dish, it is possible to arrange ten in a single ring. These also form a stable group as a ring of nine with one in the middle, or of eight with two in the middle. But a ring of seven with three inside is not possible; if temporarily so placed, one of the three moves out and joins the seven. Not until eighteen magnets are introduced is it possible to form a group with a nucleus and two rings. These are stable when placed twelve in an outermost ring, five in an intermediate ring and a single one in the centre. The moral to be drawn is that too much reliance must not be placed on applications to atomic structure of the behaviour in either of these forms of experiment, because the law of the forces between the constituents of an atom may be, and probably are, different from those existing in either of them.

ZOOLOGICAL.

By R. LYDEKKER.

The Fauna of Lake Tanganyika.

A CONSIDERABLE portion of the August issue of the Zoological Society's *Proceedings* is occupied by an account of the organisms obtained during a recent expedition to Lake Tanganyika. Several naturalists have taken a share in this work, and while some of them have not expressed a definite opinion on the subject, the general result of the investigations appears to show that the theory of the Tanganyika fauna being originally a marine one, which became cut off from the ocean and eventually adjusted itself to fresh-water conditions, will not hold good. Support to this view is afforded by a note in the same issue regarding a jelly-fish

from the lake. Since the same species also occurs in the Victoria Nyanza and in the Niger, it is quite evident that this jelly-fish is a member of a fresh-water fauna common to a wide area in Central Africa, and in no wise distinctive of one particular lake. Of the naturalists who contribute to the "symposium," Mr. J. Calman writes emphatically against the marine theory, remarking that the Tanganyika shrimps, although peculiar, are essentially fresh-water types.

A Siamese Brown Bear.

My readers may, perhaps, think there is no more reason for referring to the occurrence of a brown bear in Siam than for mentioning that white elephants are a product of that country. As a matter of fact, the occurrence of such an animal in the area in question is very remarkable indeed, for brown bears and their immediate relatives (whether regarded as races or species) have hitherto been considered characteristic of more northern latitudes, such as are included by distributionists in the Holarctic region. The new brown bear, on the other hand, whose home is reported to be the Shan States, on the Burmese frontier of Siam, is (if its habitat be rightly located), an inhabitant of the Oriental, or Indian region. Hence my reason for referring to the description. According to Mr. O. Thomas, its describer, this bear, which has been named *Ursus arctus shanorum*, is nearly allied to the race inhabiting Hokkaido, the northern island of Japan, but differs by its inferior size and certain features in the form of some of the cheek-teeth. As the skin of the Japanese brown bear has not been described, no comparison in this respect is possible.

Two Noteworthy Fishes.

In the September number of the *Zoologist* Mr. A. H. Patterson, of Great Yarmouth, records the capture of a fish of the mackerel group, namely, *Scomber thunnina*, previously unknown to British waters. The specimen was taken in a drift-net off the Norfolk town, and measured about a couple of feet in length. It is a pelagic species of almost world-wide range, which has on several occasions been recorded from Scandinavian waters. The second fish to be noticed is a new shark from South African waters, near akin to the saw-beaked sharks of the genus *Pristiophorus*, but differing in having six (in place of five) pairs of gill-slits on the sides of the body, on which account it has been made the type of a new genus by its describer (Mr. C. T. Regan, of the British Museum), under the name of *Pliotrema warreni*.

Fish as Food.

The above is the title of an anonymous article in the September issue of the *Museum Gazette* (of which the Editor has been favoured with a copy). "Speaking in general terms," observes the writer, "there can be no hesitation in saying that most sea-fish afford nutritious, easily digestible, and thoroughly wholesome food. It matters little to assert that fish contains less nutriment than beef-steak. This only concerns the housewife in making her purchases. If the chemists have convinced her that it takes a pound and a half of cod to equal a pound of steak, and if the cost of the two is the same, let her choose the steak. At table all that is needful to remember is, that if you had intended to eat half a pound of steak, you must take rather more of cod to obtain its equivalent. The most concentrated foods are, however, by no means always the most suitable. Of all fish the herring is the one most to be commended. It is good in all forms—fresh, lightly salted, or kippered—and it disagrees with no one."

More Okapi News.

Although Major Powell Cotton has not succeeded in shooting an okapi (let alone procuring a live example), he has obtained the skeleton and skin of an adult, which will no doubt arrive in due course in this country. He also obtained some important information from the natives of the Ituri forest with regard to the habits of the creature. The okapi, it appears, is a shy, solitary creature, retiring to the impenetrable depths of the forest at the slightest indication of the presence of man. Four different kind of leaves form its food, and its drink is always drawn from a clear running stream.

REVIEWS OF BOOKS.

ARCHÆOLOGY.

The Egyptian Heaven and Hell. Vol. 1, The Book of Am-Tuat; Vol. 2, The Book of Gates; Vol. 3, The Egyptian Heaven and Hell. Crown 8vo, cloth, illustrated, 6s. net each. (London: Kegan Paul and Co., 1906.)—The three volumes in which Dr. E. Wallis Budge treats of the Egyptian Heaven and Hell are of surpassing interest to the general reader as well as to the student of Egyptian history and literature. They form volumes XX., XXI., and XXII. of the series on Egypt and Chaldæa, published by Messrs. Kegan Paul. The first of the three contains the complete hieroglyphic text of the book Am-Tuat, with translations and excellent and deeply interesting reproductions of all the illustrations. Volume II. contains the complete hieroglyphic text of the summarised form of the book Am-Tuat, and the text of the Book of Gates, with translations and reproductions as in Volume I. The third Volume, which the neophyte must attack first, contains explanatory chapters on the Books of the Dead generally. These books were designed to provide the souls of the dead with a guide to the journey that they must undertake in order to reach the Kingdom of Osiris, and furnished them with passwords to the "Islands of the Blessed." Among much that is superlatively interesting we can only note the curious and suggestive fact that in the later Dynastic Period the blessed were believed to live for ever in the Kingdom of Osiris, feeding upon the heavenly wheat of righteousness which sprang eternally from his body.

BOTANY.

Rambles on the Riviera, by Eduard Strasburger. Translated from the German by O. and B. Commerford Casey (T. Fisher Unwin; 21s. net).—The fact that this book is by Dr. Strasburger, Professor of Botany at the University of Bonn, and universally acknowledged as one of the most brilliant of botanical investigators of his time, will naturally lead the reader to expect something exceptionally interesting, and his anticipation will be found fully realised. The author's many rambles have made him familiar with the beautiful scenery and natural productions of this favoured coast. In the introduction advice is given to intending visitors; to those in good health and only anxious to enjoy the charms of Nature; also to those whose state of health demands care as to choice of localities. Naturally the Flora receives the greatest share of attention, but the author's primary object was not to study botany or to write a history of the Flora of the district, but to enjoy the beautiful and interesting under whatever guise presented, hence we encounter sketches, told in charming language, concerning the peasants of the district, their traditions, folk-lore, &c., the ancient history of classic places destroyed by Saracens or attacked by Corsairs, the true account of the "Man in the Iron Mask," and many other equally fascinating incidents. In dealing with plants, not only those that are indigenous, but also introduced kinds receive attention, and the amount of information respecting their introduction, uses, ancient and modern, told in language free from the pedantry of attempting to pose as a man of science, as is too frequently the case, is quite a revelation. There is a very interesting chapter on plants furnishing perfumes, and the means of extracting the same as practised in ancient times and at the present day. Such headings as "Lemons in Symbolism," and the uses of palms in religious and other ceremonies also suggest interesting information. The beautiful garden situated at La Mortola, the property of Sir Thomas Hanbury, afforded the author many apportunities for conveying interesting information relating to plant life. In the translators' preface it is noted that it was at the suggestion of this generous patron of botany that the present work appears in an English garb. The book is beautifully printed, and the text is adorned by numerous well-executed coloured illustrations of flowering plants, seaweeds, butterflies, and vignettes of places of interest.

A Text-Book of Botany, by John M. Coulter, A.M., Ph.D. (Appleton; 5s. net).—This book is intended for use in secondary schools, and represents the combined judgment of the author and many other experienced teachers, as to the nature of the material and the points of view. The result is

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a marked success, and places all concerned in the teaching of botany under an obligation to the author, not that books dealing with the subject are lacking, but in the majority of instances they are of such a nature that the author alone can possibly benefit by their production. A notable feature is the ring of life that pervades the book from beginning to end. We miss the usual chapters retailing in orthodox fashion certain structural features, definitions of leaves, flowers, &c. All these points are considered as a matter of course, but in conjunction with the reason for their presence. The living plant is the one object kept in view, and in this important essential the book differs from most others, which suggest an unwritten apology to plants for furnishing so many features of interest when viewed under a microscope. In addition to the parts dealing with structural and physiological matters and the larger groups constituting the vegetable kingdom, there are chapters on Plant Breeding, Plant Associations, and Forestry. The 320 illustrations are all good, some excellent.

The Study of Plant Life for Young People, by M. C. Stopes, D.Sc., Ph.D. (Alex. Moring; 3s. 6d. net).—An excellent book for young people desirous of learning the why and wherefore of plant life. The author commences by stating: "Many people do not realise that plants are alive." Quite true; in fact, there is no internal evidence in the majority of books on botany to prove that their respective authors realised this fact. The student is first led to realise that plants are living things by carefully indicating the signs of life presented by them, as breathing, eating, growing, moving, reproduction, &c. Simple and well chosen experiments that can easily be performed by the student are a noteworthy feature of the book. Although so essentially modern in tone, lapses to the old order of things are observable here and there, as, for example, when considerable stress is laid on the statement that some plants have not true flowers, &c. There are excellent chapters on "Plants in their Homes," and "Plant-Maps." Several whole-plate reproductions from photographs are excellent, but some of the figures in the text are scarcely up to the same standard.

CHEMISTRY.

Practical Methods of Inorganic Chemistry, by F. Mollwo Perkin, Ph.D., pp. viii. + 155 (London: A. Constable and Co.; 2s. 6d. net).—This little book is a model of what a practical text-book should be, and it supplies a distinct want. As the author points out, there are numerous handbooks devoted to the preparation of organic compounds, but none in which the same method of teaching has been applied to inorganic chemistry, and he has written this book to fill the gap. After an introduction and a chapter on general preparations and methods there come chapters dealing concisely with the preparation of salts, halogens, and halogen compounds, metallic oxides, acids, metals and metalloids, and the work concludes with a chapter on special preparations, followed by useful tables and an index. Theory accompanies the practical work step by step, and the student who has worked his way conscientiously through the different exercises will have gained a good grasp of the principles of chemistry. The book is well printed, and has good illustrations of apparatus where required.

Researches on Cellulose, II. (1900-1905). C. F. Cross and E. J. Bevan, pp. xi.+ 184. (Longmans, Green, and Co.; 7s. 6d. net).—Substances that would not yield crystallisable derivatives capable of being purified so as to be recognised as chemical individuals were for years shunned by chemists as unpromising subjects for research, and thus cellulose was long neglected, in spite of its importance as a structural compound in the vegetable world and its increasing use in manufacturing processes. It is largely owing to the systematic and untiring researches of Messrs. Cross and Bevan that we are at last beginning to know something of the probable constitution of the cellulose group of compounds, and the present work is another valuable contribution to a very difficult subject. The first section of the book gives a concise summary of the chemical reactions and structural form of cellulose. In the second section, which forms the bulk of the book, we find abstracts of various investigations made by the authors and others, with critical notes on the results, and a discussion of the possible bearing of these results on the chemical constitution of cellulose. Lastly comes a section giving a brief but most interesting account of the progress that has been made in the cellulose industries during the last five years. In the making of artificial silk, for instance, it is shown how what was little more than a curiosity in 1899, is now being manufactured at the rate of at least 7,000 kilos. per day, while the fibres of the best products are now so fine as to be only about twice the weight of the natural silk fibre. A short description of the different artificial silk processes is given, including the authors' own "viscose" process, and other uses of "viscose," such as in the sizing of paper and the manufacture of a plastic material, are also described, and the section concludes with suggested avenues of investigation in paper making, textile bleaching and finishing, and other industries. The book is excellently printed in clear type, and has a good subject index and an index of authors' names.

GEOGRAPHY.

Rhodesia: Geodetic Survey of South Africa. (Vol. III., Cape Town, 1905. London Agents: 36, Basinghall Street, E.C.; 146 pp., 10s.).—In spite of manifold discouragements this valuable work is making headway under the energetic direction of Sir David Gill, who is now, however, retiring from the post of H.M. Astronomer at the Cape, which he has so ably filled. This volume contains a convincing statement of the reasoning by which the Cape Government was brought to admit the importance and urgency of the Survey, and, better still, to sanction it. We read also of the special difficulties and dangers of the work, and of the troubles, some unavoidable, others due to regrettable misunderstandings, which hindered the progress of the Survey, and in particular one such misunderstanding, which cost two whole months at a critical time of year, and invalided one of the surveying staff, and thereby prevented the completion of the programme laid down, so that this volume does not quite cover the whole of Rhodesia south of the Zambesi. The Jäderin method, with Jäderin wire standards, was employed, and details are given of the elaborate precautions necessary to secure accuracy. The two base lines were at Inseza (12½ miles) and Gwibi (13½ miles), and astronomical determinations were made at Bulawayo, Thabas Inyorka, and two or three other stations. The chief of the expeditions was Mr. Alexander Simms, who had been employed at the Cape Observatory. This is a very important contribution to the projected survey from Natal to the Mediterranean along the 30° E. meridian.

The Dead Heart of Australia, by J. W. Gregory (London: Murray, 1906; pp. xvi. + 371; illustrated; price, 16s. net.)—Although, as indicated by its full title, which we have not space to quote, this work is primarily a record of an adventurous journey through the arid deserts of the Lake Eyre district in Central South Australia, it is really a very great deal more than this, and is, in fact, one of the most valuable contributions to the physiography and past history of Australia that has been made during recent years. To the naturalist the most interesting chapter is the one in which the author expresses his views as to the character and relationships of the Australian aborigines. That the "black fellows" are not the low and degraded creatures they have been commonly represented, Dr. Gregory is fully convinced; while he is further of opinion that, in place of being hybrids between Tasmanians and some other race (as supposed by Sir William Flower), they are pure-bred Caucasians, whose nearest relations are the Veddas of Ceylon; and, we presume, the primitive race recently discovered in Central Celebes. In this view the author is in accord with opinions expressed, independently of one another, by Dr. Alfred Wallace and Mr. Lydekker. Very interesting, too, are the fossil bird-remains discovered during the expedition, of which Mr. de Vis will doubtless give a full account in due course. Dr. Gregory has also something to say on cosmical and economical subjects. As regards the first, he bids us have no fear of the desiccation of our globe so long as the sun continues to give out its present amount of heat; while in respect to the proposal to flood the Lake Eyre district by a canal to the sea, the author points out that since the cost would run into tens of millions, the project is scarcely within the field of practical politics. A thoroughly entertaining book, containing a vast amount of scientific lore, is our verdict on Dr. Gregory's volume.

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MATHEMATICS.

A System of Applied Optics. H. Dennis Taylor (Messrs. Macmillan and Co., 30s. net).—This is a notable book. Although many of the most important advances in optics have been made in England, there has been in recent years no text-book in England written from a practical standpoint similar to the important technical treatises of Czapski and Rohr published in Germany. Academical treatises there are in abundance and of high quality, but the standpoint from which these are written is such that in none of them is the subject treated in such a way as to enable a reader directly to calculate the form of lenses necessary for producing an efficient combination. This is the more astonishing inasmuch as Mr. Taylor, who now succeeds in supplying the deficiency, does so on the basis, not of any foreign text-book, but of an old English text-book, viz., Coddington's treatise on the reflection and refraction of light. The chief object in the present volume has been "to arrive at a complete system of algebraic formulæ of the second order which can be applied to any optical system likely to occur in practice with results which, in general, very closely approach to accuracy." This is done with the employment of quite simple algebra, so that no one need be deterred from reading the book on account of deficiencies in mathematical equipment. The reader is supposed to be already acquainted with the usual formulæ of the first approximation. He must master a new convention in regard to signs which at first sight looks somewhat elaborate, but which works out very well in the sequel. When so many conventions already exist no concern need be felt at the creation of a new one. We have nothing but admiration for the way in which the subject is developed, leading to formulæ which include and run parallel to Seidel's famous five conditions which require satisfaction in the production of a combination perfect to the second order. It is impossible to go into detail in regard to the general treatment. The characteristic note is the great freshness and originality everywhere displayed. There is no doubt at all that the treatise will rapidly take its proper place as one which will bring back to England its original prestige in optical matters. In regard to the style of publication there are two matters for regret. It is a pity that the numerous diagrams do not immediately accompany the text which they illustrate, but are collected together in the old-fashioned way in groups upon plate pages. It is also a pity that there is no index, although the orderly development of the subject makes this omission less important than it otherwise would be.

PHOTOGRAPHY.

The Year-Book of Photography. Edited by F. J. Mortimer, F.R.P.S. (London: "The Photographic News"; price 1s.).—This annual has gone through many changes since it was established nearly fifty years ago. After a list of Societies, there follows a vast collection of formulæ that have reference to negative making, and then eight excellent articles on printing processes by as many different authors, with a large collection of formulæ appended to each, and then more formulæ and tables. Apparently all the instructions of the principal makers of photographic materials are included, and the source of these is obvious, but we should like to have seen the authorities given for a large number of formulæ, the sources of which are not acknowledged, and some of which are called "standard." We would suggest that this collection of formulæ might be suitably tabulated or brought into some system of expression, for then they would be much more useful to many who do not slavishly adhere to one maker's instructions, and those who do this can always get what they want from the maker whose goods they use. One example of the desirability for editing such a collection will suffice as an illustration. The two following are given on opposite pages; the source of the first is not stated, the second is headed "Rotary Stripping Films." They are sensitizing solutions for carbon tissue.

	1	2
Potassium bichromate	1 oz. - 35-50 grms.	1 oz. - 30 grms.
Water..	20-30 ozs. - 1000 c.c.s.	30 ozs. - 900 c.c.s.
Ammonia (·880) ..	60 mins. - 6 c.c.s.	1 drm. - 3·5 c.c.s.

Obviously this is the same formula, and it need not have been set down twice, but the metric equivalents are peculiar. How one ounce can have the variable metric equivalent in one case and a quite different equivalent in the other, how 30 ozs. in the metric system can be less than 20 to 30 ozs., and as 60 minims are equal to one dram, how the metric equivalents can be so different as shown, would puzzle even an experienced worker.

Chemistry for Photographers. By Chas. F. Townsend. Fourth Edition (London: Dawbarn and Ward, Ltd.; price 1s. net.).—When a book has run to four substantial editions it may well claim to have established itself, and in a measure to be above criticism. However, the author can claim that he is only following in the footsteps of Hardwich and others in associating the word chemistry with photography more closely than seems to be justifiable. There is no chemistry involved in the publication of formulæ of solutions and the description of the operations of photography. It would have been better if the author had considerably restricted the scope of the book, for when "printing in salts of iron" occupies two pages, "printing in platinum" less than three, "orthochromatism" less than two, and so on, after practical instructions and formulæ have been given, there is little room for any chemistry.

ZOOLOGY.

A Text-Book in General Zoology. By H. R. Linville and H. A. Kelly (Boston, New York, Chicago, and London, Ginn and Co., 1906, pp. x. + 462, illustrated; price 7s. 6d.).—In this profusely illustrated little volume the authors—both well-known science teachers in New York—have initiated an entirely new mode of treating their subject. In place of starting with either the lowest or the highest group of animals (Protozoa or Vertebrata), they commence with the Arthropoda (insects and crustaceans), on the ground that, as the result of long practical experience, students can be more satisfactorily instructed on these lines than by any other method. Whether such a course will commend itself to English teachers, time and experience can alone demonstrate. So far as we can see, the treatment of the subject is remarkably even throughout, thus demonstrating the "all-round" training of its authors, and, when the number of illustrations is taken into account, the book is a marvel of cheapness. Whether it is not a little stretching terms to speak of the duck-billed platypus as "an ally of the squirrel," may, perhaps, be legitimate criticism.

MISCELLANEOUS.

George Bentham, by D. Daydon Jackson; pp. xii and 292. English Men of Science Series (Dent and Co.; 2s. 6d. net.).—As a botanist Bentham's reputation is secure, his achievements in this respect and the influence for good exercised by his sound knowledge of plants have been told elsewhere. The book under consideration will prove a revelation to many whose impressions respecting Bentham's character were formed from a casual interview in connection with scientific work, for although invariably courteous and sympathetic, his shy and reserved manner often suggested the idea that he was bored. Bentham commenced the study of botany as a boy, and thanks to his rank of birth and opportunity for rambling over Europe at an early age, he became acquainted with the leading European botanists, and familiarised himself with the floras of various countries contained in national herbaria. He studied for the Bar in a half-hearted manner, and finally decided to devote himself entirely to botany. Having determined on this course, he settled down to work in a methodical manner, and aided by good health, the possession of ample means, and a keen power of discrimination, he practically revised and placed on a truer scientific basis the flora of the world. Jackson reveals that, when off duty, Bentham in spite of his profound scientific knowledge was a society man, a lover of music, enjoyed whist, and was beloved by everyone whose good fortune it was to enjoy his friendship.

Brass and Iron Founding, by Joseph E. Dangerfield, is one of Messrs. Dawbarn and Ward's "Home-Workers' Series" (price 6d. net).—This is a thoroughly practical little book, which should prove of the greatest use to all those who have to undertake such work.

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Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Use of the Microscope in Chemistry.

THE microscope is now the indispensable servant of so many branches of science that it is always a matter of wonder to me that it is so little used in chemistry. This is probably due to want of knowledge as to the capacities of the instrument, owing to the fact that the use of the microscope as such, and more especially as an instrument of precision, is practically untaught in our science and medical schools; though most workers with the microscope would listen incredulously were it hinted that they had anything to learn in such matters, their belief being that it is merely necessary to focus the objective and make a rough adjustment with the mirror, to get the best results of which the instrument is capable. However this may be, I believe that its aid would be of the utmost service to chemists in many ways, were it more generally used, but more especially, perhaps, in regard to qualitative analyses, where the amount of material available is minute. Dr. Wormley, in his "Micro-Chemistry of Poisons," states that by micro-chemical reactions, the one-hundred-thousandth of a grain of hydrocyanic acid, mercury, or arsenic, can be readily detected with only a few minutes' labour, and Behrens speaks of the detection of 0.006μ gr. (0.000006 mgr.) of sulphur or bromine, 0.0014μgr. of silicon, and 0·00126μ gr. of magnesium. Minute as these quantities are, they are, of course, less delicate than some of the chemical reactions known to us, as in the ammonia process for the analysis of water, which can detect one part of albumen in ten million parts of water, or in spectroscopic analysis, which, according to Bunsen, is capable of detecting the three-thousand-millionth of a grain of sodium in the air. I believe, however, that further experience will show that micro-chemical reactions are themselves, sometimes, not only speedier, but more delicate than the older and better known methods, and there are many cases, where an exceedingly minute portion of substance is to be examined, in which this form of analysis is the only possible means of satisfactorily ascertaining its nature. For instance, I had myself, not long ago to investigate the contents of some sacs in a microscopic larva, upon which depended a rather important point of development. Such work would have been impossible by ordinary analytical methods, but though the whole process was carried on by polarized light and observed through a one-eighth-inch objective, the analysis itself was quite simple and straightforward, and resulted in unmistakably showing that the contents of the sacs were uric acid.

There is no doubt that methods of micro-chemical analysis need special initial training in the use of the microscope, and some preliminary patience until the slight difficulty of using an unfamiliar instrument in an unfamiliar way is mastered. They also need judgment as to when the microscope is likely to prove of service, and as to what may be fairly expected of it, and they need a natural neatness and orderliness in the worker, and some precautions with regard to the instrument and objectives. Prisms for polarized light are necessary, and the stage of the microscope should be of vulcanite or glass, whilst the objectives should be good, but inexpensive, and can be protected by attaching a small piece of broken cover-glass to the front lens of the objective by means of a little glycerine. Of course, the microscope may with advantage have many other refinements, such as those necessary for measuring crystallographic angles and axes, but these require special knowledge to utilise properly.

Preparing and Mounting Wood Sections.

The mounting of wood sections is by no means a difficult matter, but attention must be paid to several more or less important details. For the cutting of the necessary sections, the knife must be of the finest steel and with the finest edge, and the microtome must be satisfactory also. I have found the ordinary English section-knife or razor insufficiently strong for this purpose, and a properly-sharpened plane iron, mounted between two pieces of wood to serve as a handle, is far better. The wood may need softening by boiling in water for some hours, or by soaking for some days. Hard paraffin must be used for embedding, as it holds the object more firmly and shrinks less, and though it will probably roll a little, a light pressure with the ball of the finger will rectify this. The thickness of the sections is a matter of some importance, and the general tendency is to cut them too thin. If transparency is required, the sections must be bleached, but this must be done with care, as over-bleaching destroys and disintegrates the fibres of the section, whilst insufficient bleaching gives a blotchy appearance. In most cases, it is sufficient to bleach until the colour is discharged from the wood, but no longer, and to follow with a very thorough washing in many changes of water. In this connection an "anti-chlor," such as hypo-sulphite of soda, might be used with advantage, but in any case the final washing must not be curtailed. A good bleaching solution, and one which is not too drastic, is chlorinated soda, made according to the instructions given by Mr. Cole, as follows: Dry chloride of lime, 2 ozs.; washing soda, 4 ozs.; and distilled water, 2 pints. Mix the lime in one pint of the water and dissolve the soda in the other. Mix the two solutions together, shake well, and let the mixture stand for twenty-four hours. Decant off the clear fluid, filter, and keep in a stoppered bottle in a dark place (to prevent dissociation), or cover the bottle with paper. If it is required to stain the sections, Delafield's hæmatoxylin, Bismarck brown, or, for double staining, Grenacher's borax carmine and methyl, or aniline green, are perhaps the most generally useful. The hæmatoxylin is frequently made in too strong a solution. It is best to stain slowly in a comparatively weak solution, and when using hæmatoxylin, it is a good plan to wash finally in hard water from a tap, as the lime salts have a tendency not only to deepen, but to fix the colour. The Bismarck brown is useful for very delicate structures, or for large spiral or scalariform vessels. The double staining is best carried out by immersing the section in borax carmine for twelve hours or more, washing quickly, but well, in fifty per cent. alcohol, placing for two or three seconds only in aniline or methyl green, washing as before, and then again staining in borax carmine until the red appears, changing the supply of stain after the superfluous green is driven out. It has been recommended to finally mordant the

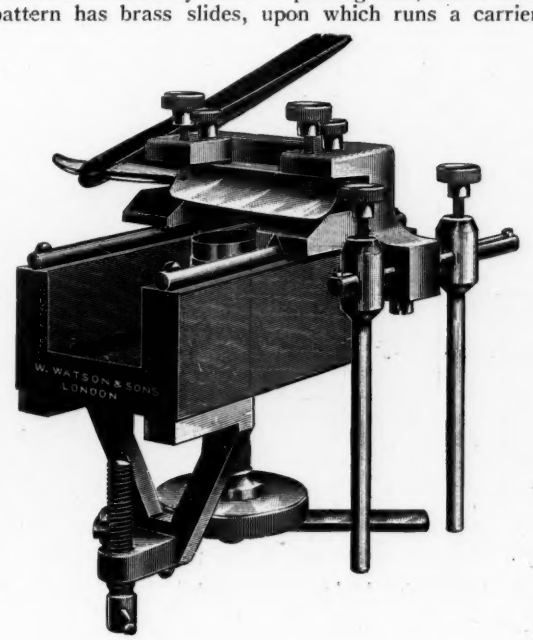
section in alum cochineal, but I have not myself tried this. The alcoholic solutions must not be mixed with the hæmatoxylin, which, in Delafield's solution, is a watery and not an alcoholic solution, and borax carmine is precipitated by strong alcohol. Almost any mounting medium may be used, but those which are used for sections in watery media are perhaps most suitable, such as glycerine jelly or Farrant's solution. Air bubbles will be found to be a nuisance, but these can be largely obviated by soaking in freshly-boiled water prior to mounting, and by carefully examining the sections under a microscope and working the bubbles out with a dissecting needle.

Staining Microscopic Animals and Plants on the Slide.

The ordinary method of fixing sections, and more especially serial sections, to the slide by means of egg-albumen can be readily adapted to the fixation of microscopic animals and plants. The albumen fixative is made as follows: White of egg, 50 cc.; glycerine, 50 cc.; salicylate of soda, 1 grm. Shake up well and filter, the last process being a slow one. Take a minute drop of the fixative and place it in the centre of the cover-glass and then smear it evenly so as to form the thinnest possible film. It is important that the slide should be absolutely clean and free from grease. Then place on the surface of the film a drop or two of water containing the organisms and allow the water to evaporate, protected from dust, until the film of fixative alone remains slightly moist. The slide can now be passed bodily through any fixing, dehydrating, staining, or clearing re-agents, and mounted in any desired way. The method is particularly useful with lowly forms of animal and plant life, especially the former.

The Cathcart-Darlaston Microtome.

Amongst inexpensive microtomes, the Cathcart microtome has long been a favourite. In its simplest form it is made with plain glass-bearing surfaces for use with an ordinary razor or planing iron, but a later pattern has brass slides, upon which runs a carrier for the razor, and by this means more uniform and better graduated sections can be cut. Mr. Darlaston has just designed a simple, but effective, addition, which allows a definite thickness of section to be cut. The illustration shows the general principle. The forks A are attached to the knife carriage, and are provided with slots, so that their distance from one another can be increased or diminished as desired, and held clamped by means of thumb screws. The distance between these forks regulates the number of teeth by which the milled head raising the object to be cut is turned, thus regulating the thickness of the section. By this means any thickness from 1/250th to 1/500th part of an inch, or even less, can be cut, for the screw turned by the milled head has 40 threads per inch and the head itself has 200 teeth. Beyond the actual cutting of the section, the most important feature is the fact that it is automatic in action. The knife carriage is moved forward in the ordinary way, the section cut, and as the carriage is drawn backwards the milled head is turned and the object raised, so that with the next thrust forward of the knife in its carriage, the material has been raised the desired amount and is ready for a fresh section to be cut. When drawing the carriage backwards, however, it is advisable to slightly tilt it so that the back edge of the razor may clear the section. The automatic gear can be at once thrown out of gear when desired, and the milled head then rotated by hand. This microtome is supplied by W. Watson and Sons, with fittings for both imbedding and freezing, at the price of £2 5s.



Quekett Microscopical Club.

The Hon. Secretary informs me that the arrangements for the series of "Demonstrations in Practical Microscopy," mentioned in our October issue, page 573, are now complete, and will be given as follows:—

Friday, November 16, Mr. H. F. Angus, on "Axial Substage Illumination with Artificial Illuminant."

Friday, December 21, Mr. H. F. Angus, on "Darkground Illumination," including the means of obtaining a darkground with objectives of high aperture.

Friday, January 18, 1907, Mr. Chas. L. Curties, F.R.M.S., on "Polarised and Multi-colour Illumination," and "Various Methods of Recording Observations."

No demonstration in February on account of Annual General Meeting.

Friday, March 15, Mr. Conrad Beck, F.R.M.S., on "The Illumination of Opaque and Unmounted Objects."

Friday, April 19, Mr. Conrad Beck, F.R.M.S., on "The Comparison of Objectives," and "Mono-Chromatic Illumination."

Friday, May 17, Mr. F. W. Watson Baker, F.R.M.S., on "The Beginner in Difficulties," a supplementary demonstration which will also deal with any questions which may arise in the course of the preceding ones.

The demonstrations will be given at 7 p.m., at 20, Hanover Square, W. Cards of admission to the demonstrations and to the ordinary meetings may be obtained from the leading opticians, or the Hon. Secretary, Mr. A. Earland, 31, Denmark Street, Watford, Herts.

[Communications and enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.]

The Face of the Sky for November.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.55 and sets at 4.33; on the 30th he rises at 7.44 and sets at 3.53. Sunspots have lately been comparatively scarce.

The position of the Sun's axis and of the centre of the disc are given in the appended table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Nov. 2 ..	24° 33′E	4° 8′	208° 38′
,, 7 ..	23° 35′E	3° 36′	142° 43′
,, 12 ..	22° 26′E	3° 2′	76° 47′
,, 17 ..	20° 2′E	2° 27′	10° 53′
,, 22 ..	19° 29′E	1° 50′	304° 57′
,, 27 ..	17° 48′E	1° 13′	239° 4′
Dec. 2 ..	15° 50′E	0° 35′	173° 10′

THE MOON:—

Date.	Phases.	H. M.
Nov. 1 ..	○ Full Moon	4 46 a.m.
,, 9 ..	☾ Last Quarter	9 45 a.m.
,, 16 ..	● New Moon	8 37 a.m.
,, 23 ..	☽ First Quarter	12 39 a.m.
,, 30 ..	○ Full Moon	11 7 p.m.
Nov. 4 ..	Apogee	noon
,, 17 ..	Perigee	1 48 a.m.

OCCULTATIONS.—The following table gives particulars of the principal occultations visible at Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			p. m.		a. m.	
Nov. 5	ν Geminorum ..	4·1	11 24	67°	12 34	276°
					p. m.	
,, 19	α Sagittarii.. ..	3·9	5 30	100°	6 34	247°
Dec. 2	χ³ Orionis	5·1	5 33	111°	6 19	231°

THE PLANETS.—Mercury (Nov. 1, R.A. 15h 47m; Dec. S. 22° 28′; Nov. 30, R.A. 16h 21m; Dec. S. 20° 18′) is an evening star, reaching its greatest easterly elongation of 23° on the 9th, and passing through inferior conjunction on the 30th. The elongation, however, is by no means favourable for observations of the planet after sunset, on account of the southerly declination.

Venus (Nov. 1, R.A. 16h 45m; Dec. S. 27° 50′; Nov. 30, R.A. 16h 19m; Dec. S. 22° 47′) remains an evening star until the 30th, when she reaches inferior conjunction with the Sun. On the 1st the planet sets at 5.26, or only 53 minutes after the Sun, and on the 30th, of course, the planet practically sets with the Sun. In the telescope the planet will present a thin crescent, 0·07 of the disc being illuminated on the 15th.

Mars (Nov. 1, R.A. 12h 7m; Dec. N. 0° 32′; Nov. 30, R.A. 13h 14m; Dec. S. 6° 33′) is a morning star, in Virgo, but is still too far from the earth for useful telescopic observation. The planet rises on the 1st at 3.21 a.m. and on the 30th at 3.10 a.m.

Jupiter (Nov. 1, R.A. 6h 48m; Dec. N. 22° 47′; Nov. 30, R.A. 6h 41m; Dec. N. 22° 57′) may now be well observed before midnight, rising on the 1st at 7.54 p.m., and on the 30th at 5.51 p.m. During the month the planet traverses a short retrograde path in Gemini, his apparent polar diameter increasing from 39″·6 to 42″·4.

The following table gives the satellite phenomena visible in this country before midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.
Nov				Nov				Nov			
1	II.	Ec. D.	9 3	14	I.	Tr. E.	9 23	21	I.	Tr. E.	11 9
5	I.	Sh. I.	9 45	17	II.	Sh. I.	8 21	22	I.	Oc. R.	8 16
	I.	Tr. I.	10 51		II.	Tr. I.	10 13	24	II.	Sh. I.	10 57
6	I.	Oc. R.	10 15		II.	Sh. E.	11 10	25	III.	Sh. I.	11 5
8	II.	Ec. D.	11 39	18	III.	Sh. E.	10 1	26	II.	Oc. R.	10 25
10	II.	Sh. E.	8 35		III.	Tr. I.	10 45	28	I.	Sh. I.	9 55
	II.	Tr. E.	10 41	19	II.	Oc. R.	8 7		I.	Tr. I.	10 38
11	III.	Tr. E.	10 15	20	I.	Ec. D.	10 42	29	I.	Ec. D.	7 5
12	I.	Sh. I.	11 39	21	I.	Sh. I.	8 1		I.	Oc. R.	10 2
13	I.	Ec. D.	8 49		I.	Tr. I.	8 52	30	I.	Tr. E.	7 21
14	I.	Sh. E.	8 24		I.	Sh. E.	10 17				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn (Nov. 1, R.A. 22h 43m; Dec. S. 10° 19′; Nov. 30, R.A. 22h 44m; Dec. S. 10° 11′), in Aquarius, remains in a favourable position for observation, crossing the meridian at 8.3 p.m. on the 1st and at 6.9 p.m. on the 30th. The motion of the plant is retrograde until the stationary point is reached on the 13th, after which it is direct. At the middle of the month the outer major and minor axes of the ring are respectively 41″·3 and 4″·6, while the polar diameter of the globe is 16″·4. At 4 p.m. on the 23rd, the planet is in conjunction with the Moon.

Uranus (Nov. 15, R.A. 18h 27m; Dec. S. 23° 37′), is unfavourably placed for observation, on account of its southerly declination and proximity to the Sun. The planet is in Sagittarius, setting at 7.35 p.m. on the 1st and at 5.47 p.m. on the 30th.

Neptune (Nov. 15, R.A. 6h 54m; Dec. N. 21° 58′), rises shortly after 7 p.m. and crosses the meridian at 3.16 a.m. on the 15th. The planet is situated about 1½° N.W. of ζ Geminorum.

METEORS.—The principal meteor showers during the month are the Leonids and Andromedids; the Moon will be near *new*, and should therefore not interfere with observations this year.

Date.	Radiant.		Characteristics.
	R.A.	Dec.	
Nov. 14-16 ..	150°	+22°	Swift, streaks. (Great Leonid shower)
Nov. 17-23 ..	25°	+43°	Very slow; trains. (Great Andromedid shower)

Algol will be at minimum at 9.34 p.m. on the 15th, and at 6.23 p.m. on the 18th.

TELESCOPIC OBJECTS:—

Double stars: η Cassiopeiæ 0h 43m, N. 57° 17′, mags. 3½, 7½; separation 5″·7. Binary star.

λ Arietis 1h 52m, N. 23° 6′, mag. 4, 8; separation, 37″. Components white and blue; easy with power 20.

η Persei 2h 44m, N. 55° 28′, mags. 4, 8; separation 28″. The brighter component is orange, the other blue. There are also several other fainter stars very near.

XUM